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On the Silvering of Glass

By Donald E. Sharp[1]

THE earliest attempts to manufacture glass mirrors by means of a chemically deposited silver film were made by Liebig about a hundred years ago. Since that time hardly a year has gone by without some new silvering process being developed or a patent being granted for an improved method of making mirrors.

A search of the literature on silvering processes discloses a vast number of articles on the subject in a wide variety of languages. No book of formulas seems complete without its recipes for silvering glass and so many different ones are usually given that the seeker after knowledge is bewildered indeed. Silverman and Neckerman conducted a systematic study of the methods of precipitation of silver in mirror form in 1917 and their work still stands as the most complete review of the subject in the literature.

The silvering process starts with the selection of suitable glass which is cut to the desired sizes. Before the chemical mixtures can be brought into use, it is essential that the glass be thoroughly cleaned. The next step is usually to warm the glass on a specially constructed warming table and finally to pour over the glass surface the mixture of chemical solutions. After a short time the silver is completely deposited out of the solution and the surface of the plate is coated evenly with a brilliant film of metallic silver. After being washed and dried the mirror receives a coating of paint over the back to prevent the silver film from being scratched and tarnished.

Some mirror manufacturers find no advantage in warming the glass. Others consider it a very necessary part of the operation. Some silvering mixtures will not work except when the glass is warm but there are mixtures that will not produce a good result if the temperature is much above average room temperature.

Perhaps the most puzzling thing about silvering glass is the fact that widely different formulae can be used. Yet fairly slight variations in the proportions of a particular formula often render it practically useless. The chemistry of the formation of silver mirrors remains unexplained in spite of the huge amount of research done on silver and its reactions in photography. Although we cannot say why it happens, we can at least tell how to produce a firmly adherent and brilliantly reflecting silver film.

Two solutions are generally used in the process; these are mixed and immediately poured over the plate. One of the solutions always contains silver, the other always contains a reducing agent. Variations in the processes sometimes call for three or even four solutions, but the resultant silvering mixture is always a silver solution mixed with a reducing agent.

Among the reducing agents that have been found to work satisfactorily are loaf sugar, glucose, formaldehyde, Rochelle salts, sodium tartrate, tartaric acid and so forth. If cane sugar is used it is invariably accompanied by a small amount of nitric acid which inverts the cane sugar into dextrose and laevulose. Citric acid, dextrin, tannic acid and stannous chloride will reduce the silver but do not cause the formation of a mirror. In all the processes one of the solutions is formed by dissolving silver nitrate in water, precipitating the hydroxide by means of ammonia or other alkaline hydroxide, and then redissolving the precipitate by the addition of an excess of the alkali.

The process patented by Petitjean in 1855 is the foundation of most of the processes commonly used today although it is known by various other names. Two solutions were used in this process. Solution A contained 16.6 gms. silver nitrate in 100 cc. of water. It was made by dissolving the silver in half of the water, adding ammonium hydroxide until the precipitate formed had nearly redissolved, and then making the total up to 100 cc. Solution B contained 1.21 grams of tartaric acid in 100 cc. of water. Equal parts of the silver solution A and reducing solution B are mixed to obtain the silvering mixture.

Draper's process is essentially a modification of Petitjean's process, in which Rochelle salt (sodium-potassium tartrate) is used instead of the tartaric acid in making the reducing solution.

[1] Bailey & Sharp Company, Hamburg, N. Y.

In Brashear's process the reducing solution contains the following:

Loaf sugar	90 grams
Nitric Acid (Sp. G. 1.22)	4 cc.
Grain Alcohol	175 cc.
Distilled Water	1000 cc.

For silvering a telescope mirror of 30 cm. diameter, Brashear recommended using 85 cc. of the above reducing solution together with a solution containing 15 grams silver nitrate, 7½ grams potassium hydroxide and 12 cc. of ammonia water of 0.88 specific gravity. This amount of ammonia is approximately enough to redissolve the precipitate formed by the potassium hydroxide.

The systematic study conducted by Silverman and Neckerman indicated that the concentration and temperature of the solutions had less effect when Rochelle salt was used as the reducing agent than when any of the other substances were used. This is undoubtedly the reason why the Rochelle salt method is so commonly used today.

The most common formula of this type uses two solutions made up as follows:

Solution A

Silver Nitrate	10 gms.
Water	80 cc.

When dissolved add ammonia slowly until precipitate is nearly redissolved. Dilute to 1000 cc. with distilled water and filter.

Solution B

Silver Nitrate	2 gms.

Dissolve in as little water as possible, and add 1000 cc. boiling water. To this while boiling add 1.66 gms. Rochelle salt and continue boiling for 20 minutes or until the liquid is nearly clear. Filter hot.

Equal parts of solution A and B are mixed just before using and poured over the surface of the glass.

Another fairly popular process is know as the formaldehyde process. The solutions are made up in the following manner:[1]

Solution A

Dissolve 15 grams silver nitrate in 500 cc. distilled water and add ammonium hydroxide until the precipitate just dissolves. The solution is diluted to one liter and the temperature noted.

The amount of formaldehyde to use is ascertained by placing 13 drops in a container and adding 15 cc. of the silver solution. During one minute of time the mixture should turn rose, violet, blue, gray and finally deposit a metallic film. It is stops short of depositing the film, insufficient formaldehyde has been taken. If an excess of formaldehyde is employed, the film is formed but is non-adherent. After determining in this manner the proper proportions to use, the article to be silvered is well cleaned, placed in a suitable vessel, and covered with a fresh mixture of the silver solution and formaldehyde solution in the proportions determined upon. The temperature is maintained the same as during the tests. The addition of 10 per cent of water to the mixture causes a thinner and transparent film to be formed.

An important aid in obtaining a firm adherent silver film on glass has been found to result from a preliminary treatment of the glass surface with chloride of tin. While the concentration of the tin solution seems to be relatively unimportant, very dilute solutions are always used. In a number of experiments conducted by the writer, one-tenth gram of stannous chloride in 100 cc. water was used.

This solution is washed over the glass or the glass is allowed to stand in it for a half minute or more. The glass is then well rinsed with water and the silvering solution applied. It is to be noted that if the glass is not well washed after the treatment with tin chloride, the silvering becomes streaked with reddish-brown markings wherever the tin remains in excess. Just how the tin chloride acts to produce a better coating is still open to satisfactory explanation.

Namias concluded that tin silicate was formed on the surface of the glass thereby causing more rapid reduction and better adherence of the film. Baum[2] stated that the use of stannous chloride in making silver mirrors probably caused fixation of the tin ions by exchange with some materials in the glass, and that these then act catalytically and as nuclei in causing the deposition of silver. These conclusions seem unlikely in view of recent work by Macchia.[3]

In this work celluloid, wood and galatite were coated with chemically deposited silver with and without previous treatment with tin. The time required for the mirror to appear was noted and the adherence of the film was determined by means of a specially constructed sclerometer. The results showed that immersion of the samples before silvering for 20 seconds in a dilute solution of stannous chloride greatly decreased the time of silvering and greatly increased the adherence of the film. In as much as the effect of the tin chloride was the same on wood and celluloid as it was on glass, the theory of the formation of tin silicate was disproved.

In addition to the tin chloride solution (concentration one part stannous chloride to 1500 water) experiments were conducted with a 5 per cent solution of tin chloride made alkaline with sodium hydroxide. The results obtained were the same as with the dilute tin chloride solution.

The action of tin chloride is considered by Macchia to be due to its hydrolysis in aqueous solution, increasing with dilution to the colloidal hydrosol of tin hydroxide, which on coming in contact with the surface to be silvered is converted rapidly to the firmly adherent hydrogel. If this is the case, there should be other substances which would accomplish the same results.

H. Von Wartenberg[4] attributes the accelerating action of 0.1 per cent stannous chloride solution to the adsorption of a stannous oxide solution upon the glass surface. This facilitates the adsorption and reduction of silver oxide. He found that there are other colloids that act similarly to tin chloride. Moreover, an accelerating effect of the same nature was obtained in the deposition of gold. The series in Table III indicates the degree of acceleration of silvering by various substances with which tests were made:

(BEST)		Concentration %
Stannous chloride	($SnCl_2$)	0.1
Titanium oxide	(TiO_2)	0.1
Stannic oxide (alkaline)	(SnO_2)	0.1
Zirconium oxide	(ZrO_2)	0.2
Thorium oxide	(ThO_2)	0.1
Thorium nitrate	$Th(NO_3)_4$	0.1

[1] M. A. Colton, Rev. d'Optique 3, 57-64 (1924).

[2] Fritz Baum, Chem. Zeitung 53, 354-74 (1929).
[3] O. Macchia, Chem. News 135, 197-200 (1927).
[4] Z. Anorg. Allgem. Chem. 190, 185-7 (1930).

Zirconium nitrate ....Zr.	$(NO_3)_4$	0.004
Methylene blue		0.5
Silica	SiO_2	2.0
Stannic oxide (acid)	SnO_2	0.3
Titanium chloride	$TiCl_4$	0.02

(POOREST)

It is obvious that there is room for further study of this interesting phenomenon. Certainly if there is any exchange of ions with materials from the glass, then different types of glass surfaces should cause some variation in the effect. Experiments along these lines have been initiated in this laboratory with the aim of finding out the variation in silvering time and adherence of film when the surfaces to be silvered are fire polished, freshly fractured or optically polished. Further tests should be made on glasses with varying resistance to atmospheric attack. That the composition of the glass can make some difference is indicated by an experience of the author several years ago.

A concave mirror had been ground and polished from a disc of low expansion borosilicate glass containing a few per cent of lead. This mirror was silvered in the usual way and after a couple of weeks had tarnished so that it required resilvering. The silver film was therefore removed in the usual manner by means of dilute nitric acid, and after the glass had been washed an attempt was made to resilver it. All that could be obtained was a smutty brown stain that had no resemblance to a mirror. It has since been determined that this glass is quite a stable one as long as the surface is fire polished, but that with a ground and polished surface it is much less resistant to atmospheric attack. No attempt is made here to explain the above phenomenon, but it is evident that, in this case at least, there was some effect from the glass.

Wadsworth in the *Scientific American Supplement*[5] says in a footnote, "It is a remarkable fact which has probably been noticed by all who have had much silvering to do, that it is much more difficult to silver on a worked (i.e., ground, polished) surface than on one from which the natural blown surface has not been removed."

The handling and storage of silvering solutions are matters that should be given some thought in any silvering plant. In the first place silver is expensive, and the waste liquors from silvering contain very appreciable amounts of silver that may be recovered by a suitable refining process. Secondly, the fact should not be overlooked that ammonia and silver can react to form a detonating material which is decidedly explosive. Berthollet pointed out the dangerous properties of this detonating silver over 100 years ago. Whether or not this compound is a nitride of silver or an unstable isomeric form of some silver oxide—ammonium complex is not known. For increased safety, dilute stock solutions should be used. Waste liquors should be precipitated by means of hydrochloric acid or common salt, and acidified slightly.

The various troubles that may be encountered in the silvering process can generally be easily avoided. The difficulties fall into two groups (1) troubles due to lack of cleanliness of the glass, and (2) those due to faulty solutions. Of the former, by far the most common is the occurrence of an uneven deposit due to failure to wash the glass carefully. However, trouble is frequently encountered in the silvering of door-knobs and vacuum flasks due to the presence of sulphur on the glass. This gives a yellowish color to the silver. The source of the sulphur is usually in the lehr but may come from the gas used in the reworking of the glass in the case of vacuum bottles. One way to avoid the difficulty is to wash the glass well immediately after inspection even though the silvering must be postponed until later. A silver deposit that is reddish or brown on the back is usually due to traces of sulphur in the solutions or the atmosphere. Such a coating may be whitened by immersion of the silver in a dilute solution of ammonium carbonate.

Of the difficulties caused by improper solutions, the most common one is failure to obtain either any deposit at all, or anything more than a streaky one. This trouble is usually due to excess of ammonia in the silver solution, but may be due to failure to boil the reducing solution long enough when using the Rochelle salt mixture. Pinholing, or obtaining a silver film full of tiny transparent spots, is due to sediment in the solutions or wash water. The source of this is frequently the ammonia water, and it may be remedied by proper filtration of the solutions. A fairly stable glass should be used for holding the stock solutions.

Most of the difficulties in the silvering process may readily be avoided if the following rules are followed:

1.—When making the silver solution avoid an excess of ammonia by leaving the solution decidedly brown.
2.—Filter the solutions and keep them in a container made of a good grade of glass.
3.—Use C. P. chemicals.
4.—In the Rochelle salt reducing mixture, bring the water to a boil before proceeding with the solution of the silver and salt.
5.—Cleanse the glass to be silvered very thoroughly. Firmly adhering dirt may be removed by rubbing.
6.—Treat the surface with dilute tin chloride solution and wash with distilled water.
7.—Have the silvering bath and glass article at the same temperature (about 20° C. or 69° F.).
8.—When silvering hollow or irregular shapes rock the container or keep the solution in motion.

There are many variations in the silvering process that are of interest. One of these is the production of half-silvered mirrors for interferometers, prisms for binocular microscopes and so forth. Dilution of the silver solution with water causes the deposition of a thinner film. Alternatively, a thinner and harder film may be made by using colder solutions. Generally, the warmer the solution the heavier and softer the deposit will be. Some manufacturers operate their silvering tables so that the glass is at a temperature of about 40° C. (104° F.). For first-surface mirrors, it is preferable to silver repeatedly until a thick enough coating is obtained, rather than to rely on a single thick deposit that is so soft that scratching is inevitable if any attempt toward polishing is made.

It is also interesting to note that the silvering process has been applied to dentistry. An infected tooth may be treated with ammoniacal silver solution, so that the solution penetrates into the unhealthy dental tissue. Singularly enough, the healthy tissue is non-absorbent. A reducing solution is

[5]Vol. 39 p16076 (1895) also Zeit. für. Inst. Jan. 1895.

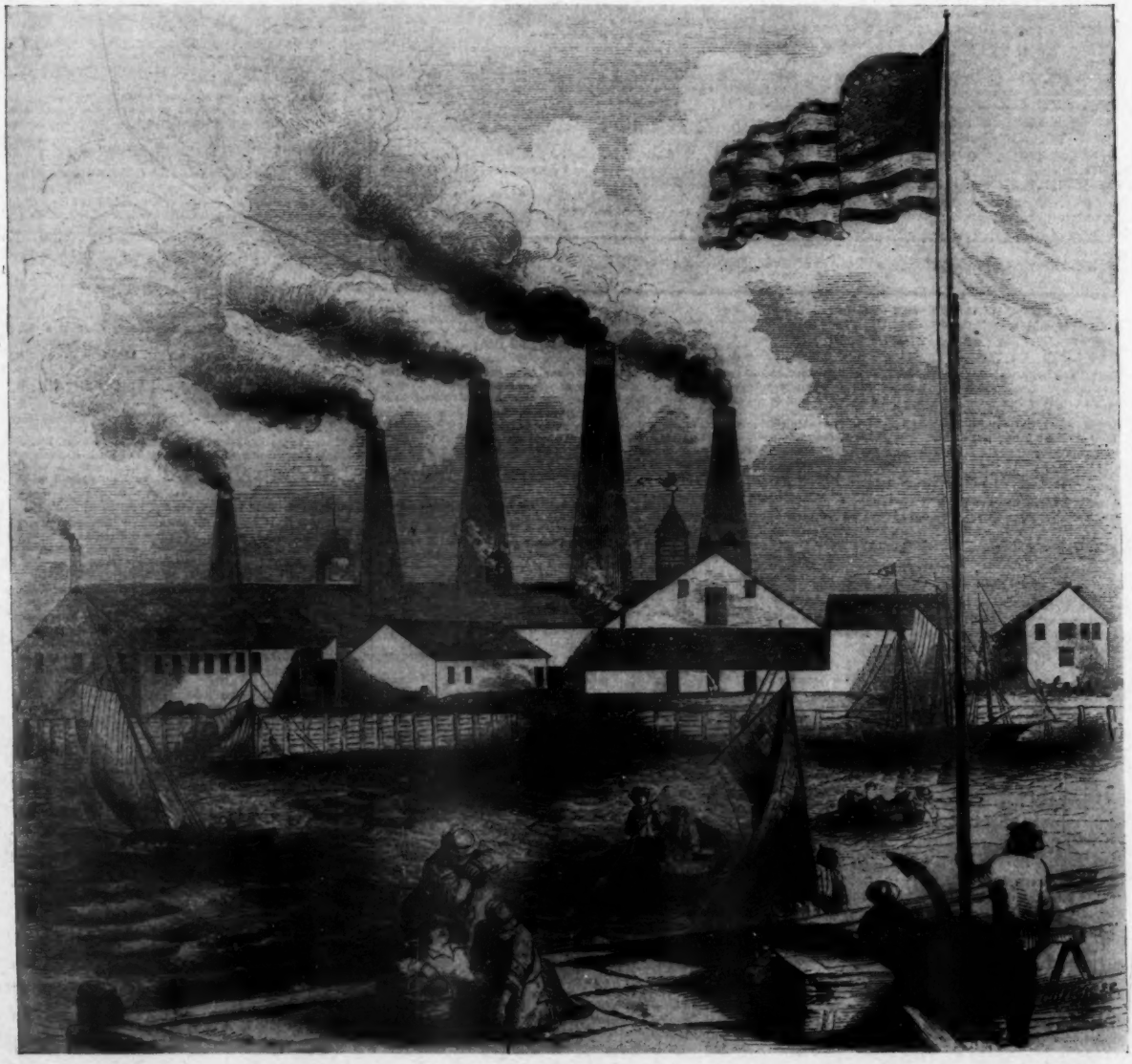
then applied, and after its absorption the ammoniacal silver solution becomes reduced and metallic silver is deposited. In this manner porous tissue or minute cavities may be actually filled with metallic silver. In this method of treatment scrupulous cleanliness is essential to good results. Similarly in any silvering process, be it for mirrors, vacuum flasks, or other uses, there is one precaution that should be placed before all others if consistent results are to be obtained. This precaution is thorough cleanliness of the article to be silvered.

An Old Timer

The illustration on this page and the short description of the former American Flint Glass Works plant at Boston is reproduced from an old article in "Gleason's Pictorial Drawing-Room Companion" of April 23, 1853. This magazine, of which F. Gleason was proprietor, was published from the Museum Building, Tremont Street, Boston, Mass. The article as it appeared, follows:

American Flint Glass Works

Below we give the reader a fine view of these famous works, as seen from Boston harbor. The works are situated in South Boston, and are a monument of enterprise and thrift. It is not long since a raging fire destroyed the company's works, but phoenix-like they have arisen from the ashes. Mr. P. F. Slane is the proprietor and overseer of the whole business. The establishment is now in a most successful condition, and is busily turning out all kinds of cut and pressed glass ware, of the most beautiful and varied styles. A very large number of employees are constantly engaged upon the works, in duties as curious as multifarious. The immense chimneys, five in number, which are requisite to the furnaces, are named Cotopaxi, Vesuvius, Aetna, Tyro, and Vulcan. Every portion of the business is performed here, cutting, designing, packing, etc., forming a most busy scene to the eye of the visitor. No stranger visiting Boston should fail to make the acquaintance of the gentlemanly proprietor, Mr. Slane, and examine the works which we have depicted.



VIEW OF THE AMERICAN FLINT GLASS WORKS, SOUTH BOSTON, FROM THE HARBOR

The Manufacture of Rolled Plate

By ERNST LUTZ *

(*Continued from the November, 1930, issue*)

This work has been revised, so far as the English and the technical expressions are concerned, by F. W. Preston, who has also added a number of notes relating in general to the special conditions of American practice; but it must be understood that the opinions expressed in the text are those of Mr. Lutz, and neither the Editor nor Dr. Preston accepts responsibility for them.

THE danger that the glass may catch drops of the vault, which appear as stones in the sheet, is evidently appreciably greater with a flat vault than with a high one. To facilitate the sidewise running off of crown drops, it has been suggested to design the vault as shown in Fig. 15, where the slightly protruding edges (s) of the bricks are intended to catch and hold drops. It is however very likely that through

FIG. 15

FIG. 16

their exposed position these edges themselves would be more readily attacked by the flame than a smooth surface, so that the forming of crown drops would not be reduced but rather increased. It is thus very doubtful whether preference should be given to this design. The work of the bricklayer has certainly to be very closely controlled and checked, so that the bricks meet as accurately as possible, and that the finished crown has not the appearance of Fig. 16, which, in any case, is inferior.

The life of the furnace vault is much affected by the design of the arches of the furnace doors which transmit the load of the furnace vault on to the support pillars. In Figs. 8 and 11, as indicated, the door arches are built up of large refractories of special shape, while those in Figs. 9 and 10 are made up of small Dinas bricks of standard shape. Also the burners of this particular furnace consist of standard size bricks; the lower part of the burner ports, i.e., about 3 to 4 layers above the furnace bottom, is made up of clay bricks, the rest of Dinas bricks. The furnaces illustrated in the other figures, however, also use the large fireclay special shapes for this part of the furnace. Of course large special shapes are more expensive than standard bricks and also have to be kept in exact sizes and dry in stock. Repair work on furnaces built up of standard stones is appreciably cheaper and takes less time than on furnaces using large form bricks. On the other hand, furnaces with large form bricks can be said to last longer. With standard bricks and in particular with Dinas bricks which show a marked growth, great care has to be exercised when slackening or tightening the stays, as otherwise the interconnection of the many small stones may give way, and in such a case it may happen that parts of the door arch fall into the furnace and that the burner bridge (h) rises somewhat, causing the development of cracks (p), which in turn create a communication between the melting room and the cooling ducts (q) (Fig. 10). Again the partition walls between the rising air and gas channels may give way and cracks (r) be found, through which the air penetrates into the gas supply, causing pre-ignition. With such a furnace a sufficient number of large inspection holes have in any case to be provided, so that all parts of the brick work can be inspected and repaired if necessary.

Of great importance is the careful and reliable construction of the furnace bottom. Usually the cooling ducts are covered with 2½″ to 4″ thick clay plates, on the top of which the actual bottom plates, each of about 10 sq. ft. and 12″ to 16″ thickness and consisting of best clay, are placed. Instead of these plates, very often the whole furnace bottom is tamped as a unit and tempered up together with the furnace. A tamped bottom is cheaper than one built up from plates. The tamping is done in layers and has to be carried out very thoroughly so that the whole bottom is one compact mass, without any airlocks. If, while the furnace is in commission the bottom cracks sufficiently to let stray glass get in the fissures, it will not be long before it also reaches the regenerator chambers and the furnace has to be shut down.

For the manufacture of the bottom the following composition is used. Five parts of well cleaned scrap-pot fragments and two parts of fresh burnt clay with about 25% Al_2O_3 content. For this purpose the pot-shell is crushed, pulverized and sieved through ⅜″ mesh, while the fresh clay is pulverized and sieved as finely as possible. The whole is well mixed and as little water as possible added for binding.

(Regarding the supervision of plate glass furnaces from a heat economy point of view, see Vol. I, Chap. 6 of "Dralle-Keppeler, Die Glasfabrikation.")

Melting Pots for Plate Glass

The preceding section on melting furnaces and the work in the glasshouse has already given some indication of the importance of the form and quality of melting pots for the manufacture of plate glass. In its essential features the equipment and run of the pot house of a plate glass plant is but little different from that of other glass industries; however, the size of the pots and the severe conditions to which they are subjected require an extra high workmanship. A plate glass melting pot is withdrawn daily from the furnace, thus undergoing large temperature variations. Furthermore its handling by the pot removing and casting machinery, involves a rather heavy mechanical stress, particularly so with its large dimensions and its great volume of glass.

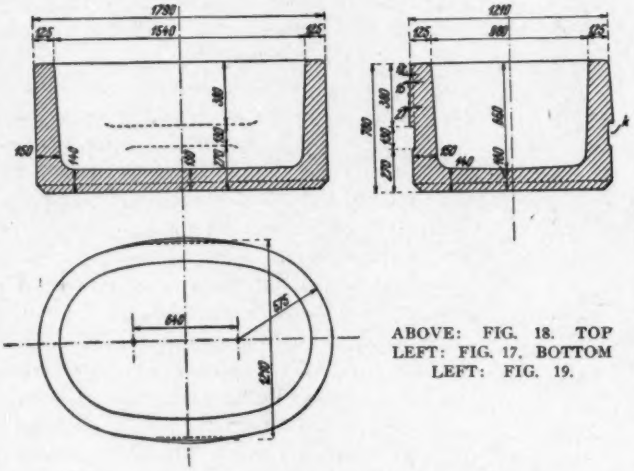
Volume I, Chapter 7, of the above named book deals more fully with the raw materials and their treatment for the manufacture of melting pots. The pots are almost exclusively hand-formed. Methods for mechanically forming or casting the pots have so far not been able to get a footing in the plate glass industry to any appreciable extent; the pot factories of this industry still adhere to hand-spreading and tamping of

* Of Dessau, Germany. This work will appear in German in the forthcoming new edition of Dralle Keppeler, "Die Glasfabrikation," due next year, about July. The GLASS INDUSTRY probably will by that time have completed the English translation, with some comments on its applicability to American conditions by F. W. Preston.

the clay; the tampers may be air or electrically operated but are held and guided by hand. The spreading of the clay by hand, one thin layer after the other, is still the best means to ensure that the potwalls become homogeneous and contain no air.

As to the form of the pots, the circular pot offers the greatest resistance to pressure from the inside and to shocks from the outside but on the other hand it is least suitable with regard to the efficient utilization of the floor space of the furnace. Assuming the same volume of molten glass and the same thermal efficiency, the furnace with round pots has to be appreciably larger and uses a good deal more fuel, than one with longish pots. Also a circular pot cannot be held by the tongs with the same safety as an oval one.

Against the circular form goes also the fact, that with circular pots it is most difficult to pour the glass mass without the formation of bubbles and strings in front of the roll so that the sheet after rolling covers the casting table as



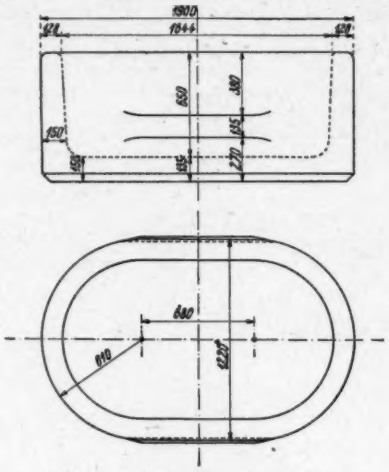
ABOVE: FIG. 18. TOP LEFT: FIG. 17. BOTTOM LEFT: FIG. 19.

completely as possible and that the form of the rough plate glass sheet is, as perfectly as is practical, a rectangular one. The longer the pot and the more extended its side walls, the better and easier the teeming; the less, however, is the strength of the pot as a whole. Circular pots are still in use in some American glass works; in Europe the "oval" plan, really elliptical, has been almost exclusively adopted.

Figs. 17 to 25 show some of the commonly used pots. The dimensions given are in millimeters and refer to air-dried, unburnt pots. In this connection the first illustrated pot when brimfull, holds about 165 gallons* (26½ cu. ft.), the second one more than 187 gallons* (30 cu. ft.). Both these sizes are in use in glass factories, which are otherwise equipped to roll rough and uncut sheets of nearly 420 square feet and normal thickness (⅜" to 15/32"). It may be inferred therefrom that with the same furnace capacity some factories are working with smaller, but fuller pots, while others operate with larger, but less full pots.

Figs. 20, 21 and 22.

The smaller and fuller pots are of course more liable to overflow in the process of refining. An uncut rough sheet of about 410 square feet surface takes on an average 91* gallons of glass. In the pouring of the glass it cannot be avoided that an appreciable part of the pot content drops besides the casting table; further, if this table is fully utilized some glass must overflow the table end. Again, depending on the viscosity of the glass a certain amount of it will remain in the pot after the pouring. Available for casting are thus about 143 gallons of glass, in the case just considered. The



ABOVE: FIG. 20. BELOW: FIG. 22.

level of the glass when ready for casting in the smaller pots stands 3½" to 4" and in the larger pots 6" to 6¾" below the pot brim.

When full to the top, the pot shown in Figs. 23 to 25 contains about 225 gallons* (36 cu. ft. of glass, but just before pouring there are actually about 187 gallons available,

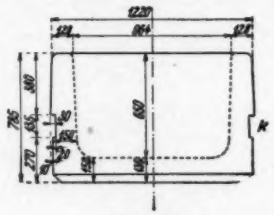


FIG. 21

standing at a level of 4⅜" to 4¾" below the top of the pot. The rough, uncut sheets, cast and rolled thereof have a surface of up to 500 square feet. The second of the illustrated pots has straight side walls, whilst the two others approach an oval form.

The dimensions of melting pots depend above all on their height. Most glass factories have arrived at a clear height of 25" to 26",* measured in the center of the pot from its bottom to the plane of its rim. As the bottom thickness usually increases† towards the sidewalls, the clear pot height near the walls is somewhat less. Large pots, as for example, illustrated in Figs. 23 to 25 have a depth of 27 to 27½". The dimensions always refer to the pot when air-dried. The higher a pot in proportion to its volume, the more difficult becomes a thorough refining; inversely with the lower pot, assuming equal capacity, the larger must be its cross section with corresponding large surface and "skin" of molten glass.

* Imperial gallons. In American gallons the figures would be 25% higher.—*F. W. P.*

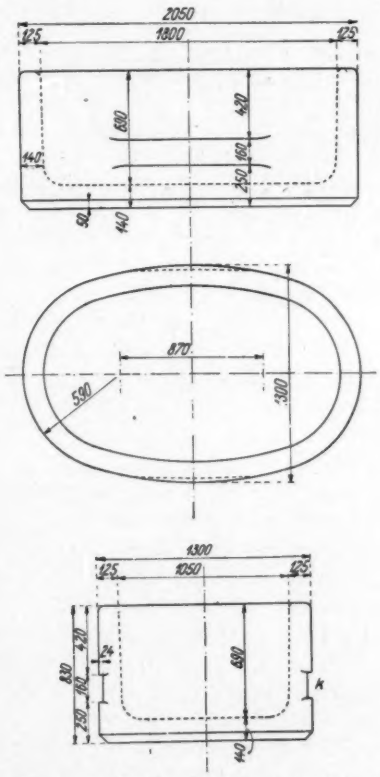
* European practice. American pots are often deeper—*F. W. P.*

† Not in American practice.—*F. W. P.*

If it was stated before that some factories work with smaller but more completely filled pots, and others with large but less filled pots, it must be observed that, though the glass surface level is higher in the smaller pots than in the larger ones, the latter have a contaminated "skin" of greater surface.

A further point influencing the choice of the potform is the action of the flame in the furnace. It is assumed that a predominant part of the melting heat is supplied by direct radiation of the flame onto the surface of the batch and a small part only by the flow of heat through the pot walls which as refractory materials rather hold back the heat. It is thus evident that the lower the pot and the wider its surface exposed to the radiation of the flame, the more rapidly the fusion process will be finished.

The thickness of the side or walls is fixed by the required strength of the pots, however, the sides are kept as thin as permissible, in order to enhance its heat conductivity. On the outside the wall stands vertical to the pot bottom, whilst on the inside it shows a slope, i.e., the wall section is tapered. The increase of the wall thickness towards the bottom is not only necessary for reasons of strength, but also to ensure a gradual transition from the sides to the bottom; this is particularly important for a safe drying process. The slope of



TOP: FIG. 23. CENTER: FIG. 25. BOTTOM: FIG. 24.

the pot inside is at the same time desirable for the pouring of the glass. Originally the bottom, even with larger pots, had a thickness of 4" or maximum 4⅜", however, the knowledge that the heat transmitted through the bottom has but little influence on the rate of melting, led to an increase in its thickness. Today 5" to 6" strength is common practice, and this not only means an increased strength of the pot, but has the further advantage that in refining, when the flow of heat through the bottom goes from the inside of the pot to the furnace bottom, this latter remains cooler, than with a thin pot bottom, thereby reducing the danger of after-boiling of the glass mass, i.e., the belated rising of gas bubbles, which are caught in the upper layers of the molten mass. The weight of the pots illustrated, when empty and air-dried varies between 2,500 to 3,100 pounds.

Good pots, as described and depending on the quality of the glass aimed at, i.e., the temperature prevailing during refining, on an average last about 16 to 25 fusion processes if salt cake is used and 25 to 40 cycles if soda ash alone is used.

Thus with salt cake and a furnace of 16 pots, it can be assumed that each working day one pot has to be replaced. Further—each freshly formed pot takes about 8 months* for thoroughly drying out. For every furnace therefore a stock of pots for a period of 8 months must be kept, which amounts to about 200 pots. Whenever a new pot is put into service another one must be manufactured. To have a certain margin a stock of 225 to 250 pots is usually held for a furnace of 16 pots and one fresh pot is moulded per working day. If soda ash is used, the figures mentioned can be cut appreciably. (Concerning new drying methods see "Zeitschrift des Vereins Deutscher Ingenieure" No. 26, June 28, 1930: v. Reis, "Neuzeitliche Spiegelglasherstellung.")

When first put in commission, the pot is preferably filled with cullet only; through this procedure the inside of the pot acquires a glass skin, which acts as a protective coat against the strong chemical influences of the subsequent batch melting. If there is not sufficient cullet available for a complete fill, two or three small cullet charges are made first, and only when the last is fully molten, is batch material added. The life of pots depends very much on their proper setting on the furnace bottom, great care has therefore to be taken that after teeming the pot is brought back exactly to its original place in the furnace. To remove the pots from the furnace some force has usually to be applied, as they stick to the bottom by reason of stray glass or through the baking together of the refractory materials. The seat or "siege" of the pot thus becomes somewhat torn up and rough; furthermore most pots distort after a few fusion processes, so that during casting the siege in the furnace has to be equalized with soft clay, ensuring that the pot rests again uniformly and adapts itself to the furnace bottom.

The sides of the pots facing the furnace doors keep cooler than those opposite, i.e., towards the inside of the furnace. The wear on this side is consequently less and the wall remains thicker and stronger. Sometimes attempts are made to lengthen the life of the pots by turning them round about once every fortnight, but in this case they no longer fit exactly in the old seats and may break on account of being supported on a few points only. As stated before, the rim of the pot suffers very much, if hit directly by the flame; this happens particularly with humid fuel or with gas producers working with ample steam injection, so that the heating gases contain a good deal of water gas. On account of this latter

* Not so much in American practice.—*F. W. P.*

cutting flames may be formed, which are very harmful to the pots.

Many pots must be replaced, because the inside of the pot bottom corrodes in deep pits, which may grow to such dimensions, that, long after the refining, gas bubbles still arise from them: the deeper these pittings the longer this formation of gas bubbles will last.

The air-dried pots coming from the pot house, because of their size and elongated form, have to be treated very carefully. For their insertion into the furnace two-wheeled trucks as shown in Figs. 26 and 27 are used. The drying process hardens the pots to such an extent that they can be handled with the same tongs as are used in working the furnace. To this end the pots are fitted with grooves or

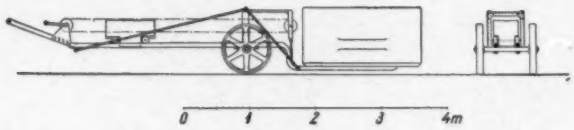
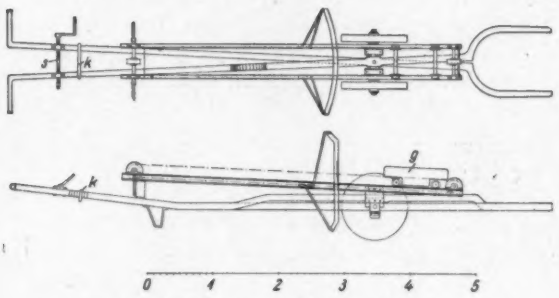


FIG. 26 FIG. 27



ABOVE: FIG. 28. BELOW: FIG. 29.

"belts" k (see Figs. 17 to 25), which, when the pot has its normal charge of glass, are about in, or slightly above, the horizontal plane through the center of gravity. In a few cases there are still pots in use, which have these grooves appreciably below the center of gravity; the pots in this case are less troubled by any jamming of the tongs, but their transport is not so easy.

For the withdrawal and insertion of the pots from and into the furnaces, pot removing machinery is used.

Figs. 28, 29 and 30 show hand-operated tongs, which were originally in general use and are still to be found in some factories. The tongs are opened and closed with the aid of a threaded shaft s, and as a safeguard against accidental opening, carry a safety bracket k. The weight of the pot, which inclusive of its contents, amounts to about 5,900 to 7,600 pounds, is balanced in the first illustrated case by a runnerweight g. With the idle tongs, this weight g is near the tong-jaws, so that the weight of the long handles, is partly balanced; when the pot is gripped, the weight is moved to the opposite end. In the case of the tongs shown in Fig. 30 the frame r, carrying the handles of the tongs, is so heavy that it more than balances even the full pot when gripped. The turning of a handwheel p on a a vertical spindle moves the tong handles and with it the pot up and down. To protect the workmen somewhat from the heat, a fine netted multiple wire sieve is very often fitted in front of the wheels.

The withdrawal of the pot from the furnace with such hand-operated tongs requires 5 to 7 men on the job. It would be awkward also to convey the pot with this heavy vehicle to the casting table, hence if the teeming crane cannot travel over the furnaces or at least very close to them,

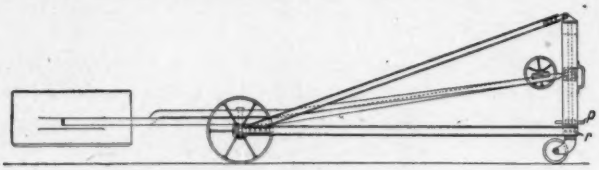
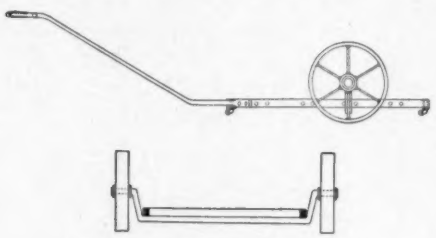


FIG. 30

the pot is set on a low truck as shown in Figs. 31 to 33 and so brought to the casting table or within the range of the casting crane.

All these manipulations not only require many workmen, whose strength and resistance are heavily taxed, but they take also a lot of time. The casting of course is not



ABOVE: FIG. 31. BELOW: FIG. 32.

delayed because while one pot is in the process of pouring, the next one can already be on its way from the furnace to the casting table; the pots however are a long while outside the furnace and cool down appreciably, furthermore the furnace doors have also to be kept open for a long time.

The removing of the pots with this rather primitive device has therefore been abandoned. Only extra strong and enduring men were able to stand the work. It was indeed very impressive to see those sinewy figures, in the light of the flames shooting out of the furnace, working on the heavy trucks and great glowing pots. It is not by chance that the Belgian painter and sculptor Meunier chose this scene as one of the components of his famous monument "Work" erected in Brussels, which fascinates the onlooker by its impetus and truth to life. (Fig. 34.)

In the following section some mechanically operated pot-removing machinery is described, which facilitates the work, requires less men and permits the withdrawal and insertion of the pots much faster. (Figs. 35 to 39.)

For the first illustrated device Belgian patent No. 192999 dated 23d of June, 1906, was granted to R. Zimmermann of Messrs. Zimmermann Hanrez & Cie., Monceau sur Sambre. The figures 35 to 37 are reproduced from an old edition of "Dralle Die Glasfabrikation." The tongs in this case are pivoted at the lower end of a beam 14, which itself is fixed to the trolley 4 of an overhead travelling crane. The crane bridge 1 spans the whole width of the casting-hall. The two arms 23 and 24 of the tongs turn on the pivot 22 and further pass through the guide 25, which is fixed to the beam 14. Relative to the beam the arms of the

tong are thus able to turn only around the pivot 22; this movement is effected by the threaded shaft with the hand-wheel 27. The movement of the crane bridge 1, of the trolley 4, and the raising and lowering of the beam 14 inclusive of the tongs, are done with the aid of separate motors. The beam 14 is so suspended from the trolley that, together with the tongs, it is balanced by the weight 15, whilst the pot itself, when gripped by the tong, is situated vertically below the point of beam suspension so that it does not affect the balance.

The parting of the pot from the furnace bottom is done electrically by raising the beam 14, and manually supported by lifting the tongs at their handles 21. The travelling crane permits the conveying of the pots right through the casting-hall into reach of the teeming crane, so that the glass-filled pots can be directly taken over by the latter. The current for the motors is fed in the usual way through sliding contacts, situated on one or the other side of the crane bridge rails.

The tongs require a good deal of space on either side of the furnaces; the span of the crane bridge needs therefore to be very large, resulting in a heavy construction. The strong pillars of the building walls, which carry the crane rails increase the cost of the building appreciably. With such a pot-removing travelling crane it is impossible to have overhead silos and bunkers for the batch material. The operations, however, require only 3 men, one for the crane itself and two at handles 21. It is somewhat of a handicap that the man on the crane, in order to see the operation with the tong, has to change his place whenever pots are removed from one or the other side of the furnace. In the U. S. A. this machine has been so perfected that only one man is required for its operation.

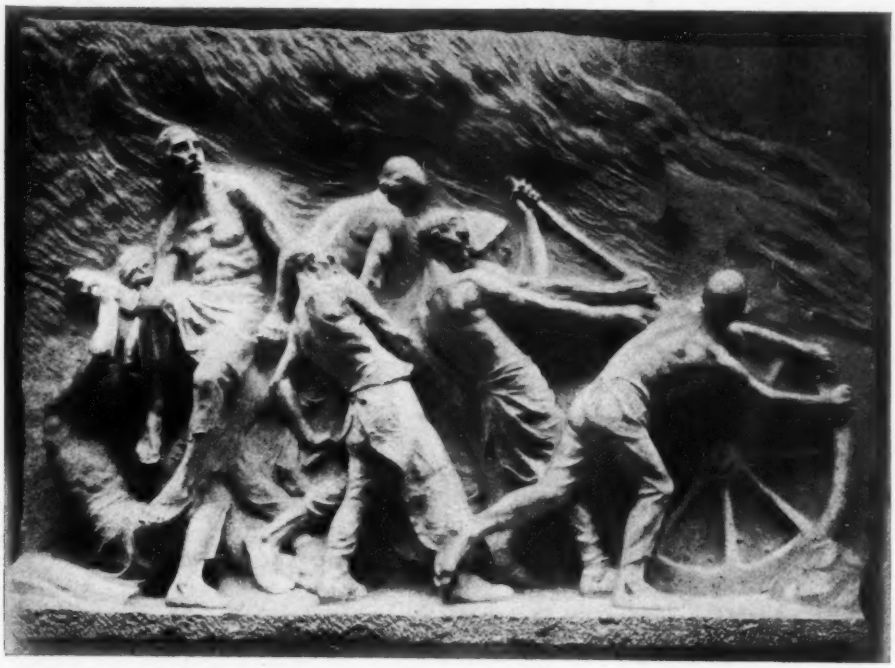
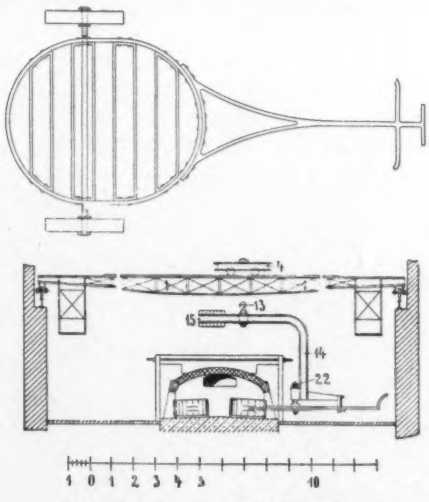


FIG. 34



ABOVE: FIG. 33. BELOW: FIG. 35.

The second-illustrated pot-removing machine in Figs. 38 and 39 runs on rails on the shop floor. As the furnaces have to be served on both sides, this machine has to be brought with the aid of a turntable from one to the other side of the furnace. It is however preferable to have separate machines for each side as otherwise too much time is lost when casting. Usually the teeming crane has such a range as to reach the pots on either pot-removing machine; if not, the pot must either be set on a special truck, as for example shown in Figs. 31 to 33, or the aid of a turntable must again be resorted to.

The tongs must be movable in the direction of the main axis of each pot in the furnace; as these however differ (*see Vol. I, table VII, Fig. 3 of Dralle-Keppeler, Die Glasfabri-*

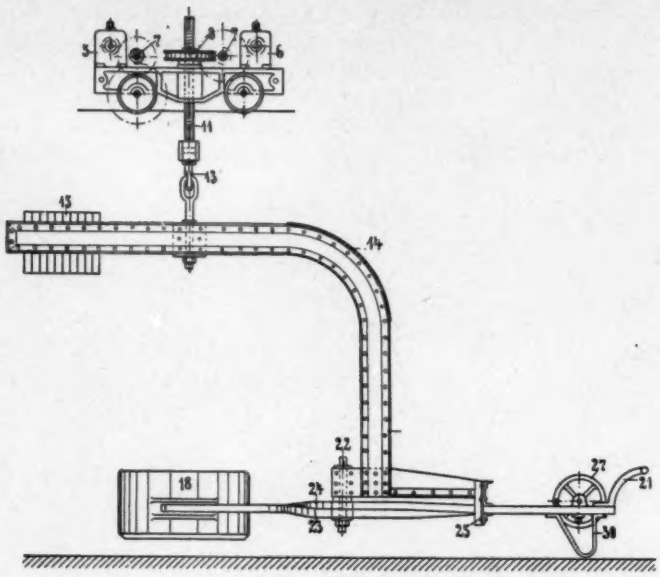
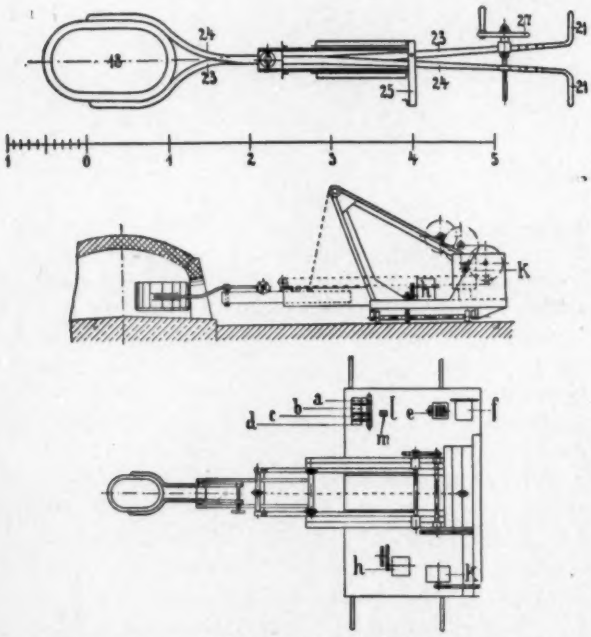


FIG. 36

kation) the tongs, together with the upper part of the truck, must be able to turn round a vertical axis.

Figs. 40 and 41 show a modern design of such a pot-removing machine with a separate sliding platform on which the tongs can be raised and lowered. This platform can be moved to and fro on the truck, and, by means of a



TOP: FIG. 37. CENTER: FIG. 38. BOTTOM: FIG. 39.

turntable, it can also swivel on a vertical axis. German patent No. 250,210 of Aug. 2nd, 1910, was granted to Messrs. Charles Henze, Auvelais, Belgium. For this device, in which the truck proper carries a turntable, which in turn is fitted with a traverse table holding the tongs, so that the latter can be set true along the axis of each pot and insert or withdraw pots without a further movement of the turntable. Fig. 42 illustrates this type of pot-removing machine, with a pot gripped.

In Figs. 40 and 41 A indicates the chassis running on rails alongside the furnaces driven by the electric motor B. This chassis carries the circular rails A^1 for the wheels of the turning platform C, which is pivoted at D. The movement of the turntable is effected through a worm drive, a gear wheel segment U and the electric motor V. The swing of the turntable is limited and less than 360°, as it is necessary to vary the position of the tongs only according to the longitudinal direction of the pots in the furnaces.

On the two lengthwise girders of the turntable frame C, rails E are placed, on which the traverse table G rolls forwards and backwards on four wheels E′, being driven through a worm and worm wheel by the electric motor S. The driving shaft of the traverse table is fitted with a gear wheel R, engaging with a rack Q on the turntable C, thus preventing any sliding of the wheels E′ on the rails E, which otherwise would happen in the course of lifting and withdrawing the pots from the furnace.

The tongs L are carried by the traverse table G and turn round pivots in the cross girder H. The rear ends of the tongs are guided in an aperture of the cross girder I. Both cross girders H and I are mounted in one arm of the two lever pairs F and F′, which in turn move round axle J. The pot, when gripped, is lifted by the motor T, driving the shaft J through a worm gear, thereby moving the bent lever F′. The bar K imparts the movement to the levers F.

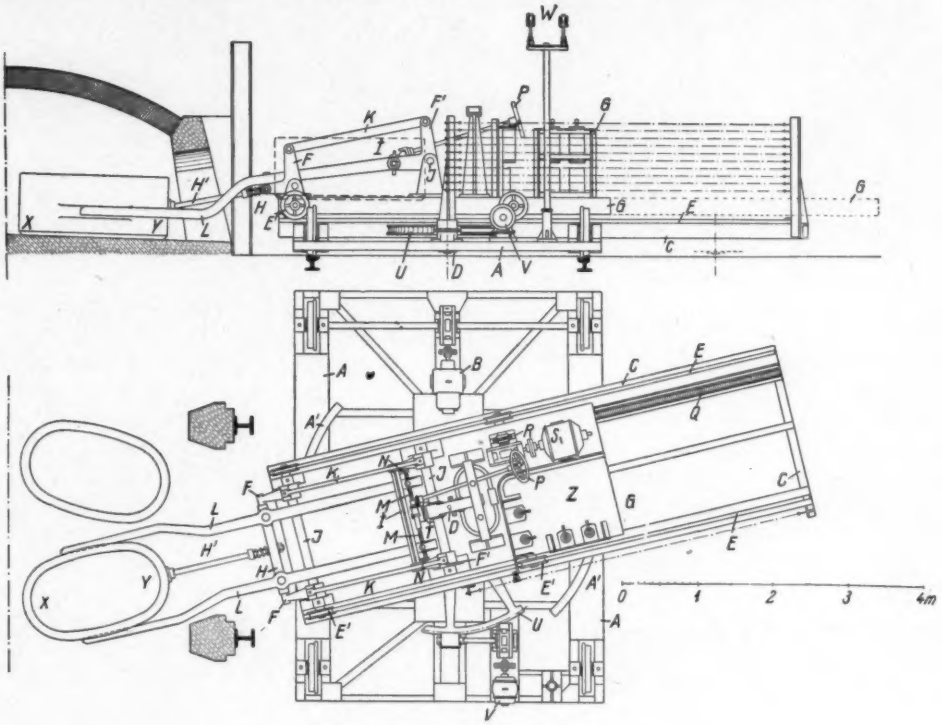
The lower arms of the bent levers F′ are slightly longer than those of the lever F, consequently the cross girder I will be lifted somewhat more than the girder H, so that in its highest position the pot hangs level, whilst in its lowest position its slope corresponds with that of the furnace bottom. The tilting movement thus given to the pot exerts a force which tends to turn it round the point X and lifting it in the first instance at Y. The severing of the pot from the furnace bottom is thereby facilitated.

The tongs are opened and closed with the handwheel P, which by means of bevel gears turns spindle M provided with right and left hand threads. Spindle M rests in bearings N of the cross girder I and in its movement carries with it the tong shanks L. The operator's stand Z is situated on the traverse table G; from it the four motors for the manoeuvring of the chassis, the swivelling of the turntable, the moving of the traverse table G and the lifting and lowering of the tong shanks, i.e., the turning of the bent lever pairs F and F^1, as well as the handwheel P for opening and closing the tong, are operated.

The electric current is fed to the chassis through the contacts W, and with hanging cables or segments, arranged concentrically with the pivot D, to the contact leads on the turntable C. From this lead, the current on its way to the motors passes the starters and the regulating rheostats. The cross girder H is equipped with a bar H^1, mounted with springs, which checks the depth of the tong grip on the pot, so that the operator cannot push the traverse table too far ahead or grip the pot too short. In the ordinary way when the pot is not sticking too much to the furnace bottom, the operator alone manages to handle the pots; otherwise he is assisted by another man in breaking the contact between pot and furnace with an iron rod; if this is not done, the "belts" of the pot may suffer. If fragments of clay are still breaking off during casting, they will be trapped and rolled into the sheet.

With such machinery the removing and handling of the pots is very much facilitated. All plants which have gone in for it have acquired two machines, one for each side of the furnace. At full speed, the chassis travels alongside the furnaces with a velocity of 500 to 600 feet per minute. The mains for the current must be so arranged that they do not interfere with the filling of the pots, and further must be at such a height, that the finishers and other workmen operating with iron rods are in no way exposed to danger. Finally the electric leads near the casting table must not lie in the working range of the casting crane, or interfere in any way with the casting.

The idea naturally suggested itself of elaborating tong-truck and tong-carrying cranes so that they would also serve for teeming the glass on the casting table, thus dispensing with a separate casting device and also with the necessity of setting the pots down between furnace and casting table. Tests have in fact been made with tong cars running on the works floor as well as with devices hanging on an overhead travelling crane. Teeming devices moving on the floor have however not proved successful, and therefore have not been adopted. On the other hand a good many overhead travelling cranes with tongs are in use, which not only insert and remove the pots but at the same time are used for the pouring of the glass mass on the casting table.



ABOVE: FIG. 40. BELOW: FIG. 41.

(To be continued)

Footnote to Ernst Lutz' Article Above

In the Figures, originally prepared for use eventually in the coming new edition in the German language of Dralle-Keppler, "Die Glasfabrikation" in 1931, dimensions are given in metres (*m*) and millimetres (*mm*). We would like to have given these in feet and inches but the translation and the making of nearly two hundred and fifty new illustrations would have involved a prohibitive loss of time and expense. To some of our readers the metric system is as familiar as the English units; for the others we may say that a metre is approximately 40 inches, and a millimetre is approximately 1/25 of an inch. A thousand millimetres, of course, go to a meter.—*F. W. P.*

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We sincerely wish all of Our Readers a Merry Christmas and Happy and Prosperous New Year. —Editor.

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The Metric System

OF all the ills the French revolution inflicted on suffering humanity, we presume the worst is the French system of units, arrogantly pre-empting to itself the title of The Metric System.[1] Napoleon (another product of the revolution) was bad enough while he lasted, but he is dead. Like a scourge he spread himself over continental Europe, and only territories beyond the sea remained immune. The "metric" system has extended its grip on the same territories, and also on South America. It is legal in English-speaking countries, including the United States. But we still have with us a fanatical group anxious to inflict on us another form of prohibition—the prohibition of English units. It is not enough that the law allows us to use either, as we please; we must be compelled to use the French system.

The arguments in favor of the metric system are (1) that it is a decimal system and (2) that it is an international system.

As regards the first, it is not unique. Mechanics and Machinists regularly decimalize the inch and Surveyors decimalize the foot. There is no law of God or man that prohibits decimalizing English units.

As regards the second, the international feature, the French system is practically confined to the Latin countries and to North-Western Europe. It is not in common use in the United States, Canada (whether English or French speaking), Great Britain, Ireland, South Africa, (whether English or Dutch speaking) Australia, New Zealand, India, or indeed most of Asia, Oceania or Industrial America.

From a scientific point of view the only thing to be said in favor of the meter as a unit of length is, that it has such a hold on the electrical industry, and this is a practical rather than a scientific reason.

The metre is supposed to be one ten-millionth of the distance between the pole and the equator. But as both the pole and the equator are imaginary points, and the pole is known to vary a little all the time, the metre is one ten-millionth of an imaginary distance, and of a distance that can never be measured with precision.

The gram is supposed to be the weight of a cubic centimeter of pure water at its temperature of maximum density. It turns out to be only approximately so, but even if it were exact, the result in scientific work is to make specific gravity synonymous with density; now specific gravity is a pure number, while density has physical dimensions (Mass-volume) and there is consequently a continual confusion in the dimensional accuracy of physical equations. Only an expert can keep his equations in order in the French system, while there is no possibility of going wrong in this way with English units.

Further, the derived French units, like the dyne (unit of force) and erg (unit of work) are so microscopic that no one wants them for practical purposes. The English units are satisfactory in this respect.

So much for the scientific aspects. From an artistic and

[1]Any system of measuring is necessarily a metric system. Metric is merely Greek for measuring.

human standpoint, there is no comparison in the interest of the two systems—the upstart progeny of a pedagogical French sans-culotte, and the cultured scion of a pre-historic line. That twelve inches (thumb-widths) make one foot is in itself an interest lesson in anatomy; it was ordained of God, not of man. That 30¼ square yards make a square rod, perch, or pole, is a profoundly interesting fact on which one may meditate for a long time with profit. But that ten millimeters make one centimeter, or a hundred centimeters make one meter is of interest to nobody; they couldn't help it. It is the difference between a Beethoven sonata and the mechanical rhythm of negroid jazz; between the Parthenon and the tenements of the east side of New York.

To return to the economic aspect of things, we may observe that together. the United States and the British Empire comprise one-third of the earth's land-surface and one-third of its population. They permit their citizens to use any system of units they like, and they use both, according to circumstances. Their women buy their food by the pound and eat it by the calorie. Are the women of France any less plump for buying it by the kilogram?

There is talk to the effect that the United States should adopt the metric system to facilitate international trade. But the United States does not want international trade; she is raising tariffs to stop it. And if she did need international trade, her best customers have always been and for long will be, Canada, Great Britain and other non-"metric" countries. In them the use of English measures helps us and handicaps the Germans and the French. Why throw away the bird in the hand to go after a bird in the bush, especially when it is known that the one in the bush is comparatively skinny? —*F.W.P.*

Carthaginian Lenses

The July issue of the *British Journal of Physiological Optics* contains a communication from H. L. Taylor on "The Origin and Development of Lenses in Ancient Times," which ascribes the development of the lens to the Cretans of 1800 B. C. His examination of the contents of museums of the eastern Mediterranean has led him to the conclusion that ivory and steatite, the materials used for beads prior to 2000 B. C., were replaced at a later period by rock crystal, onyx, agate, and cornelian. The discovery of the magnification produced by a bead of rock crystal led to the production of lens-shaped beads, and eventually of lenses such as those of the "royal gaming board" found in the palace of Cnossus and to the perfect lenses, found also at Cnossus and Mount Ida, now in the museum at Candia. They are all plano-convex with powers between 5 and 8 diopters. The Phoenicians appear to have carried such lenses to the mainland, to Troy, Tyre, Nineveh, and Britain. At Carthage five glass lenses have been unearthed at the ancient necropolis, two of them, of power 5.5 diopters, in the sarcophagus of a prominent individual, who it is presumed suffered from presbyopia and wished to protect himself against this disability in his next existence.—*Abstract from Nature, Sept.* 13, 1920.

The New Dixon All-Electric Lehr

Already in Commercial Use

(*Illustrated on pages* 286 *and* 287)

The H. L. Dixon Company, Pittsburgh, Pa. in announcing completion of plans for the marketing of what they believe to be the first lehr for entirely electrically annealing all sizes and shapes of ware and automatic handling of it from the forming machine to the packer, states that this machine has been in the process of development for the past several years.

The first lehr produced results beyond expectation, and improvements in detail and design were incorporated in each of the fourteen units that have been built. The results now obtained, all of which it is stated are substantiated by the actual data accumulated, have convinced the builders of this new machine that they are in possession of a type of lehr that is far superior to anything heretofore offered for handling a general miscellaneous line of ware as manufactured by the majority of producers.

Engineers of many of the large industrial firms and engineering concerns have been devoting much time to developing electrically heated equipment for heat treating and annealing. Vast strides have been made along these lines, particularly in the steel industry, but it is only in the last several years that particular efforts have been directed toward the annealing of glass by electricity economically.

The lehrs are built entirely of structural steel and thoroughly insulated all around, the thickness of the insulation being tapered down after leaving the high temperature zone in the lehr. The heating elements are entirely within the lehr and are automatically controlled, depending upon the temperature curve that is desired for the annealing of the ware to be placed into it. Cooling is accomplished entirely by radiation. The wire conveyor extends from end to end of the lehr, and the speed is adjustable either through a D. C. variable speed motor, or some equally effective speed changing apparatus.

Each lehr installation is provided with a conveyor from the machine to the lehr loader as occasion and layout demands. The lehr loader is actuated entirely by the head bottle of the row formation in front of the lehr.

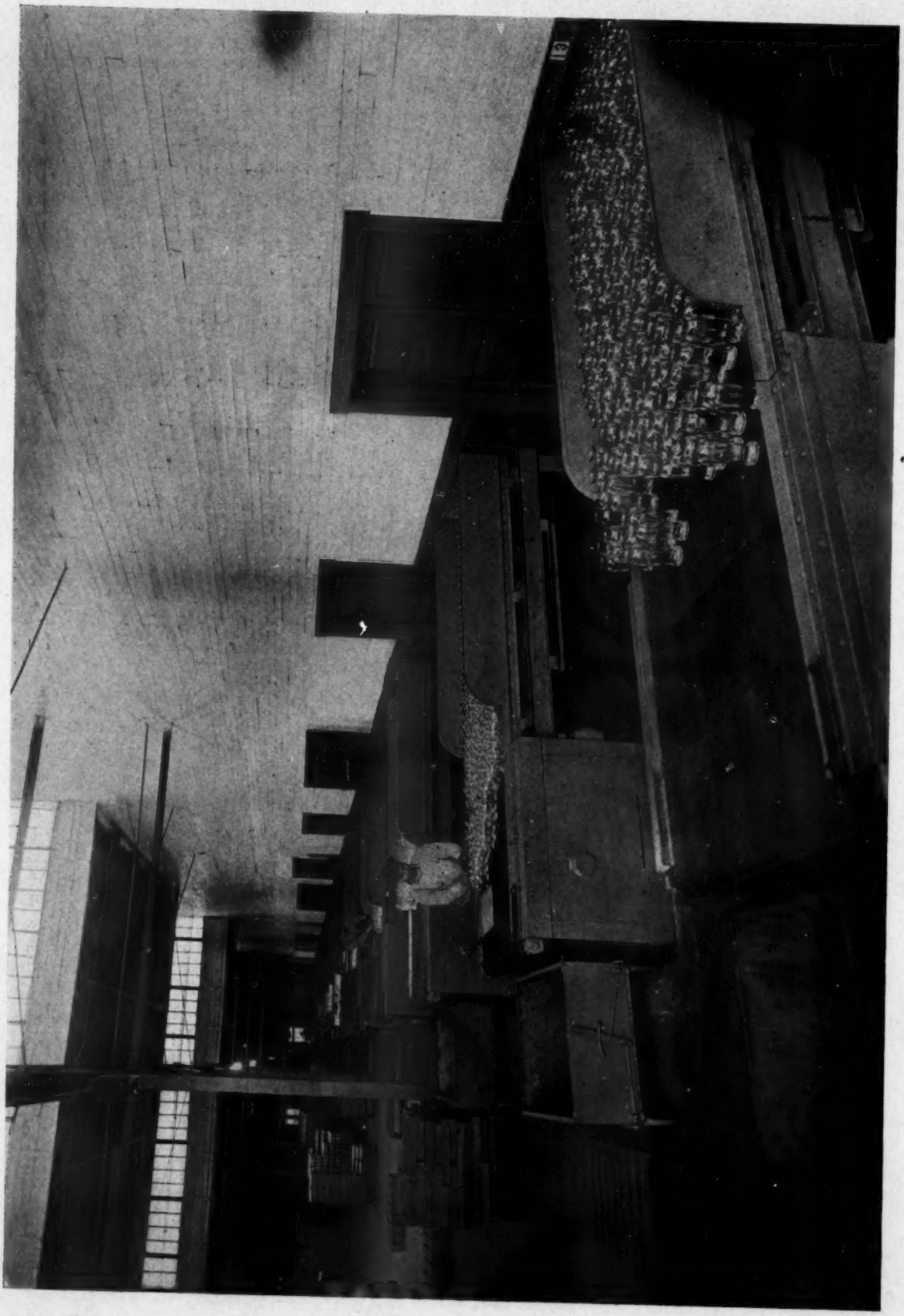
Actual operation and a check on the annealing has proved that 920 degrees F. in the lehr is about the correct temperature for best annealing results, and this is considerably lower than most gas fired or oil fired lehrs where the temperatures necessarily run about 1,000 to 1,050 degrees F. As a matter of fact in an electrically heated lehr the designers have not been required to consider the high temperatures that obtain in gas and oil fired lehrs. In other words, no high refractory combustion chamber is provided, there are no elevated temperatures destroying refractories that must be replaced every year, nor is there the risk of the lehr ever being overheated due to negligence on the part of the operator. When the lehr is too cold, or 5 degrees below the predetermined temperature of 920 degrees, the control apparatus comes into play and supplies. more heat until the temperature is brought up to 5 degrees above 920, and after that again the control apparatus comes into play until the lehr temperature drops 5 degrees below the predetermined temperature. With this positive control it is impossible to ever have destructive temperatures injuring the unit, or perhaps melting down a considerable portion of the ware in the lehr.

The heat is applied in the lehr chamber and is not transmitted through refractory muffles from fire box into the lehr chamber, resulting in substantial savings.

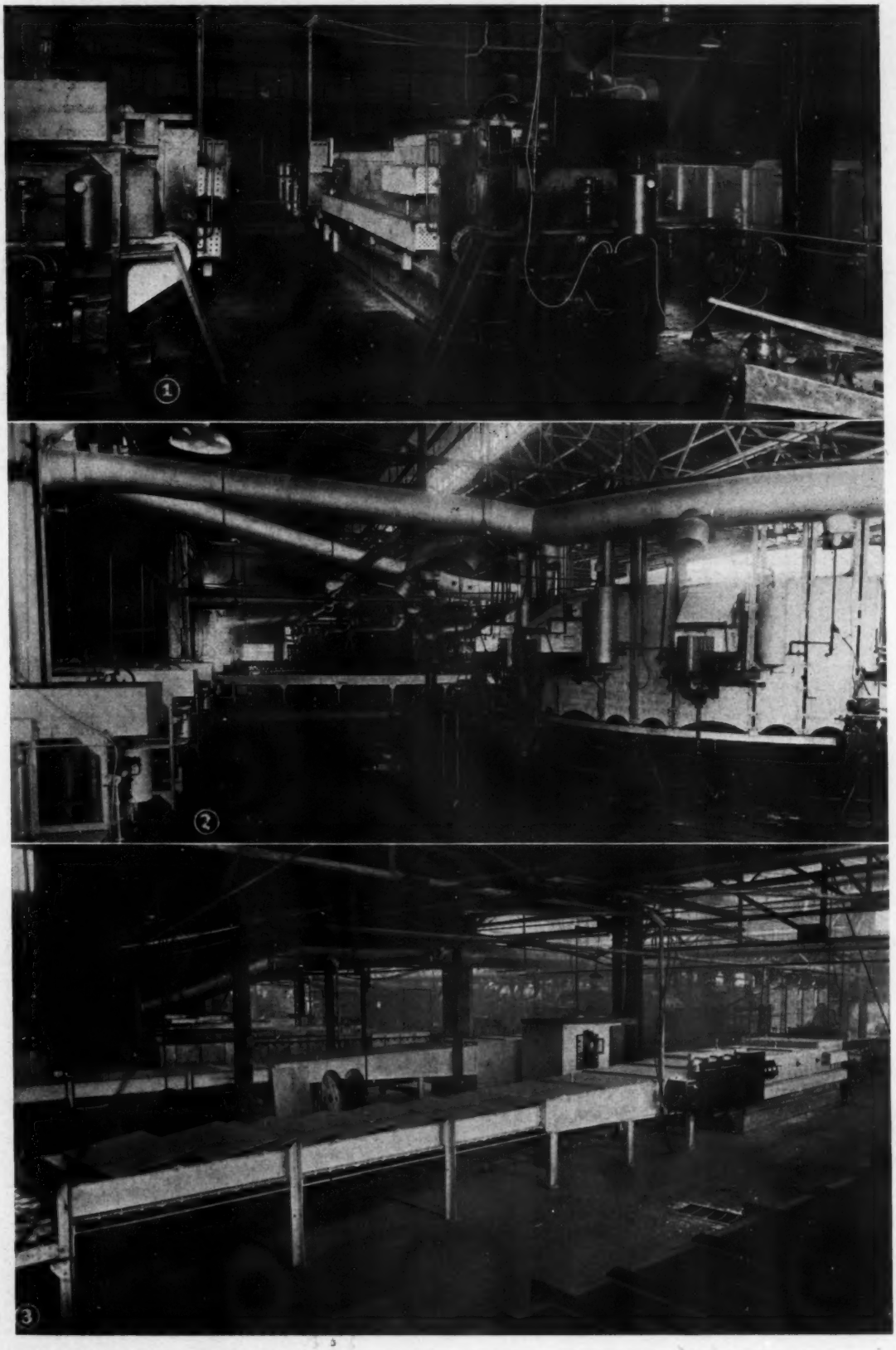
Quite an assortment of figures pertaining to the operation of these lehrs has been compiled, the sizes ranging from 1½ ounce ware to 19 ounces and over, with machine production speeds up to 28 pieces and lehr conveyor speeds up to 11 inches per minute, and in instances where the machine production demand it, the lehrs have taken 17-tons of glass per 24 hours and are, the builders state, capable of taking 20 or 22 tons without undue load.

With a single machine operation producing bottles at the rate of 130 to 280 gross per 24 hrs. the lehrs have a tonnage capacity of 6½ to 17 tons per 24 hrs. With a two machine operation 440 gross have been placed into the lehr per 24 hrs.

The power consumption varies considerably with the weight of the ware and the speed into the lehr. Performance data shows power consumption from 21 to 95 KWH per ton of glass.



GENERAL REAR VIEW SHOWING MECHANISM ENTIRELY ENCLOSED AND CONDITION OF WARE



1. TYPICAL FRONT VIEW SHOWING LEHR LOADER AND SECTION OF CONVEYOR FROM MACHINES. 2. GENERAL VIEW OF THE FRONT OF A BATTERY OF LEHRS, NOTE CLEAR FACTORY CONDITIONS. 3. SIDE VIEW SHOWING RETURN CONVEYOR AND ADJUSTABLE TOP SECTIONS FOR COOLING

Recent Patents

NEW INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

Complete copies of U. S. Patent Specifications may be obtained from the Commissioner of Patents, Washington, D. C., Price 10c each

FORTIFYING FROSTED-GLASS ARTICLES. U. S. 1,772,965. Aug. 12, 1930. Rowland D. Smith, Corning, N. Y., assignor to Corning Glass Works, Corning, N. Y. Filed 4/30/29.

In commercially frosting and fortifying articles as lamp bulbs, it becomes necessary to repeatedly use the same frosting and fortifying solutions and to add more ingredients as the strength of the solutions diminish. The maintenance of uniform strength of the fortifying solution is usually obtained by adding predetermined amounts of the frosting solution to it and since it is repeatedly used, it eventually becomes super-saturated with reaction products such as silico-fluorides and this results in the precipitation of the reaction products on the glass surfaces which impairs the fortifying process.

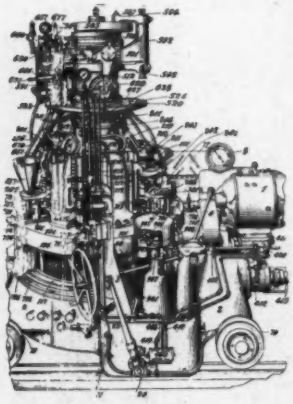
The object of the present invention is to improve the fortifying solution by keeping the reaction products in a state of solution and hence preventing their recrystallization on the glass surfaces.

In carrying the invention into practice, the inventor adds to a fortifying solution containing hydrofluoric acid and ammonium bifluoride, a small amount of boric acid. By the addition of boric acid, the cutting action of the solution is somewhat decreased, but by maintaining the boric acid content relatively low, the speed of the process is not materially affected and yet the difficulties usually encountered, due to the precipitation of the reaction products, can be overcome.

The quantities of hydrofluoric acid in the solution may vary between five and twenty percent, the ammonium bifluoride may vary between ten and twenty-five percent, while the boric acid may vary from two to ten percent according to the formula used in mixing the fortifying batch and to the composition of the glass to be treated.

It has been found that a fortifying solution containing about fifteen percent hydrofluoric acid, about twelve percent ammonium bifluoride and about two percent boric acid will satisfactorily fortify a frosted glass bulb whose composition contains about seventy-two percent silica, seventeen percent sodium oxide and about eight or nine percent lime, and that such a solution may be used repeatedly, as in commercial operations, and yet produce satisfactory fortification of the articles.

GLASS MACHINE. U. S. 1,716,792. June 3, 1930. Max Jaeger of Long Island City, N. Y., assignor to Anchor Cap and Closure Corp. of Long Island City, N. Y. Filed 4/17/22. According to the inventor this automatic pressing and blowing machine comprises a continuously rotating mold table having a constant speed of rotation, except when the speed is changed for adjustments, and wherein the feeding, pressing, blowing, and delivery operations are all performed without in any way changing the speed of rotation of the machine. Under these conditions the load is very even and the machine operates with minimum shock and jars. The power consumed is very light and since no abnormal load is produced a constant and efficient drive is the result. The specification occupies 13 pages of text matter and is illustrated with 26 full page plates.



GLASS ANNEALING LEHR. U. S. 1,773,383. Aug. 19, 1930. Percy Q. Williams, Toledo, O., assignor to Owens-Illinois Glass Co., Toledo, O. Filed 3/3/27. A glass annealing lehr comprising an annealing chamber, a ware conveyor, a heating unit at the forward end of the annealing chamber, means causing a continuous circulation, in a closed path, of an annealing medium free from products of combustion, said path extending through the annealing chamber and heating unit, means causing movement of a portion of the annealing medium rearwardly beneath the conveyor, and valve means for controlling the extent of such movement.

MANUFACTURE OF STEMMED AND FOOTED GLASSWARE. U. S. 1,775,632. Sept. 16, 1930. Virgil O. Cornwell, Columbus, O., assignor to The Federal Glass Company, Columbus, O. Filed 9/19/25. Relates to the manufacture of stemmed and footed glassware and, more particularly, the manufacture of high quality thin-walled goblets, and the like, by pressing and blowing. Fig. 1 is a vertical section of a blank or press mold with a mass of glass deposited therein, this blank mold being of such shape as to form the bowl blank and stem.

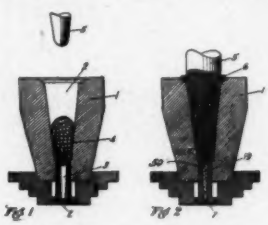
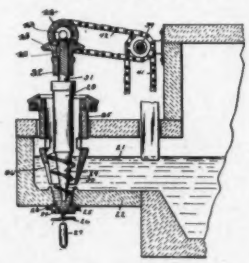


Fig. 2 is a view similar to Fig. 1, except that the pressing plunger is shown as moved into the mold and the bowl blank and stem formed.

APPARATUS FOR DELIVERING CHARGES OF MOLTEN GLASS. U. S. 1,778,775. Oct. 21, 1930. Leonard D. Soubier, Toledo, O., assignor to Owens-Illinois Glass Co., Toledo, O. Filed 5/2/24. Object of the present invention is to provide a practical form of apparatus comprising a regulating device operable to exert an expelling force on the issuing glass, which is not dependent upon and limited to a downward movement of the regulator, and which may be extended over any desired periods. If desired, this expelling force may be made continuous. Further, the invention relates to the provision of a regulator provided with a screw thread or spiral surface which may be utilized in applying either an expelling or retarding action on the glass. Such action may be effected by a relative rotation of the container and regulator, preferably a rotation of the regulator. Moreover, the rotation of the regulator may be either intermittent or continuous, depending upon the particular results desired. A further object claimed obtained by the use of a spiral or screw threaded regulator, consists in the circulation of the glass thereby, such circulation being around the axis of the outlet, so that stagnation or one-sided chilling of the glass is prevented.



METHOD AND APPARATUS FOR MAKING ARTICLES OF GLASSWARE. U. S. 1,781,565. Nov. 11, 1930. Robert J. Beatty, Columbus, O., assignor to The Federal Glass Company, Columbus, O. Filed 3/13/28.

The inventor has found that, by reblowing a blown blank the exterior surface thereof will have been cooled to such an extent by the first blowing operation that, no rib or seam will be discernible on the finished article. Investigations also show that by partially shaping an article by blowing in a one-piece mold and then finally shaping the article by subjecting it to further shaping in a mold, which may or may not be a one-piece mold, no ribs or seams will be discernible on the finished article and also the mold marks left on the article by the contact of the surface thereof with the walls of the one-piece mold will be removed.

The inventor's claims include the method of producing glassware which comprises pressing a blank in a one piece mold, blowing the pressed blank in another one-piece mold to a shape that will still allow its removal therefrom, and then blowing the shaped blank in a mold other than a one-piece mold to a shape which would preclude removal from a one-piece mold.

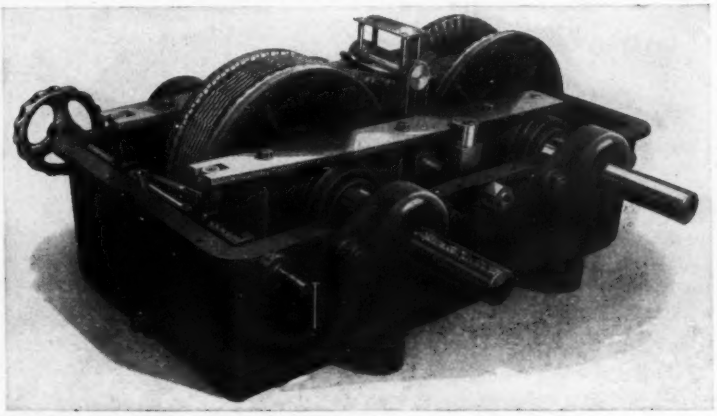
New All-Metal Variable Transmission of Unique Design

THE design of speed changing gears has become of special interest to the glass trade during the past few years on account of the increased use of these devices for controlling the speed of lehr conveyors, flat glass drawing machines and similar purposes. What is said to be the first all-metal variable-speed transmission on the market has recently been announced by the Link-Belt Company, Philadelphia. It is called the P. I. V. Gear, the initials standing for "Positive Infinite Variable," indicating its characteristics. It is driven by side-tooth chain of unusual construction.

Basically, this new speed change unit consists of two pairs of wheels of the opposed conical disc type, between which a unique chain transmits power. The effective diameters of each pair of wheels can be altered under load to change the speed ratio, without steps and without dependence upon friction. On changing speed, the self-pitching chain rises in one set of wheels and descends in the other, so that while the input shaft connected to a motor or other source of power turns at constant speed, the output shaft is brought to the desired R.P.M.

Variable-speed devices employing adjustable conical discs and belts with side friction contacts have been used for some time. The wholly original feature of the P. I. V. Gear is its use of a positive chain drive to transmit the power. Radial teeth are cut in the conical faces of the driving discs, and the self-adjustable teeth projecting beyond the sides of the chain are arranged to positively engage the radial teeth of the discs.

The chain used in the P. I. V. Gear is made up of a series of steel leaves or links with joints consisting of hardened steel pins turning in segmented bushings. There are no teeth on the inner surface of this chain. Instead, what may be called teeth are made up of packs of hardened steel laminations or slats which extend through slots in the links at right angles to them, and project about ⅛ inch at each side of the chain. The individual containers which hold the packs of slats are secured in the openings of the links, but, within each such container, the slats are free to slide from side to side individually with relation to each other and adjust themselves to engagement with the radial teeth of the discs, over substantially the full range of diameters. The angle of the slat ends, 30°, is the same as that of the conical faces of the wheels.



LINK-BELT P. I. V. (POSITIVE INFINITELY VARIABLE) GEAR, SHOWING ASSEMBLY OF MECHANISM.

The teeth of the discs widen from the center outward toward the circumference, but are of uniform depth. They are so staggered relatively on each pair of wheels that the slats move back and forth into the teeth to mesh correctly as the chain comes into contact with the wheels. Self-pitching of the chain to any tooth width or wheel diameter is thus assured. At each engagement of the chain and wheels, the slats are regrouped within their separate containers, but do not slide nor move under working pull. Their movement in engaging with the wheels is complete before the load is applied.

All elements of the P. I. V. Gear are built into and protected by a compact oil-tight housing, and are automatically splash lubricated. The hardened steel wheel faces are mounted on cast iron hubs backed by ball thrust bearings, and move axially on the shafts, which in turn are mounted in radial ball bearings. The movement of the pairs of wheels together or apart, in order to increase or decrease their effective pitch diameters, is controlled by a pair of pivoted levers operated through a hand control shaft with right and left-hand screw motion. Initial chain tension is provided for by an external adjustment screw, and correct operating tension is maintained at all ratio settings, by two hardened shoes which ride lightly on both upper and lower strands of the chain, under constant spring pressure. A speed indicator permits ready check-up on operating speed settings.

The P. I. V. Gear has been put into production by the Link-Belt Company for the present in five sizes, from 1 to 10 hp. capacity, providing speed change ratios up to a maximum of six

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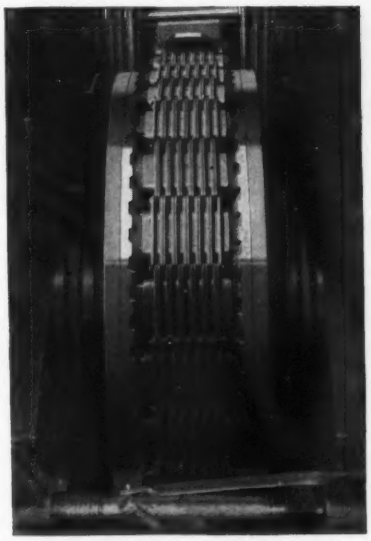


ILLUSTRATING THE TOOTH FORMATION OF THE P. I. V. CHAIN ON THE MAXIMUM DIAMETER OF A WHEEL.

ILLUSTRATING THE TOOTH FORMATION OF THE P. I. V. CHAIN ON THE MINIMUM DIAMETER OF A WHEEL.

The Glass World and What It Is Doing

News of the Industry

Professor King Describes His Trip Abroad

A meeting of the Pittsburgh Section of the American Ceramic Society was held on November 11. Officers for 1931 were elected at this meeting in view of the fact that the final meeting of the year, on December 18th, will be held in conjunction with the Pittsburgh Section of the American Chemical Society. Following are names of the officers elected for 1931:—Chairman, R. F. Ferguson, Mellon Institute, Vice-Chairman, H. M. Kraner, Westinghouse Electric & Mfg. Co., Secretary, Herman Wilcox, Harbison-Walker Refractories Co., Treasurer, J. H. Waggoner, Mellon Institute Councillor, E. W. Tillotson, Mellon Institute.

Following the election, Professor R. M. King, Ceramic Engineering Department, Ohio State University, addressed the Section on the subject, "A Ceramic Tour of Europe."

Professor King described in some detail his experiences at the Centenary of Josiah Wedgewood at Stoke-on-Trent, England. He described Wedgewood as one of the outstanding pioneers of industrial history and exhibited a number of examples of his work on the screen and one or two specimens of the actual pottery. He described also the ceremonies on the occasion. Thence he proceeded to the Swedish Exposition at Stockholm and reviewed the remarkable revival of Swedish glassware in the last few years, expressing the opinion that at the present time, the Swedish work is equal to Bohemian or better. Thence he went on to developments in Russia and described in some detail the rather wild and woolly designs that seemed to have very little in common to the rest of Europe and to express with fair fidelity the shock and bizarre themes of the Russian Revolution. Some of the designs actually depict Revolution scenes; others seem to be a cross between the post-impressionist or cubist styles of art and the "dazzle" painting of war-time ships. Some very extraordinry samples were shown on the screen.

The concluding part of Professor King's address concerned political and industrial conditions in Russia, and he expressed a great deal of sympathy with the efforts of that country to modernize itself at a tremendous present sacrifice.

Fulcher Talks to Corning Lions Club

A recent meeting of the Corning Lions Club, Corning, N. Y., was addressed by Gordon S. Fulcher, one of the company's scientists who several years ago was in charge of the development of the Corhart cast refractory block, resulting in a revolutionary development in refractories. He told of the difficulties encountered in the early manufacture of glass in the maintenance of clay pots and tank furnaces. He described how the fact that clay refractories were not entirely satisfactory resulted in the company's starting experiments in 1924 to develop blocks which would have greater density, hardness, non-porosity and uniform crystalline texture.

Dr. Fulcher stated that the Louisville plant of the Corhart Refractories Company furnished 20 per cent of the blocks used in tank furnaces during the past year. In 1930 the capacity of the plant was doubled and in 1929 a plant was started in France to supply the European trade. He also stated that experiments are being continued with the electro-cast blocks to develop their use for new purposes.

(*Continued from page* 289)

to one. The company states that it has been thoroughly tested throughout the past year by continuous operation in driving glass and paper-making machinery, machine tools, textile equipment, and that in these services it has proved wholly dependable and efficient, and by reason of its compactness and large range of speed variations, it has made possible desirable improvements in the design of several types of machines.

A book, No. 1274, illustrating and describing the Link-Belt P. I. V. Gear, will be sent gratis upon request to Link-Belt Company, Philadelphia, Indianapolis or Chicago.

Belgian Glass Trade

Recent reports from U. S. Consul Walter H. Sholes, Brussels, Belgium show greatly reduced earnings in the glass manufacturing trades of that country although it was reported that the month of September was excellent as far as sales are concerned. The last mouth-blowing glass plant was shut down at the end of September and is not likely to be reopened. The drawers of mechanically made window glass and their employers have come to an understanding to accept a reduction of 5% in wages. This caused the Concentration des Verreries Fourcault to immediately put two tanks into operation. This company has decided to allow sales to be made through exporting firms. The sole agency for the United States is reported to have been abolished. The glass will hereafter bear the individual trade mark of each factory and purchasers will have the right to specify an individual mill.

A report states that Fourcault and American controlled interests have entered agreements covering prices and productions which will be based on two-thirds for the former factories and one-half for the latter. Every step necessary as regards price concessions will probably be taken in an effort to recover foreign markets. Consideration is being given to the installation of new cost reducing glass making equipment and the utilization of gas from coke ovens and blast furnaces. The new process is already being used to advantage at the Zeebrugge factory of the Verreries de Dampremy-Zeebrugge where it is said very low costs have been accomplished.

American Window Glass Company

In the annual report to stockholders of the American Window Glass Company on October 21 for the year ending August 29, 1930 President William L. Monro explained that the lowered production during the year was due both to lessened demand for window glass and the fact that the company desired to reduce its large stock of cylinder made glass as it has entirely discontinued the use of the cylinder process. Production of specialties, however, had materially increased.

The use of the cylinder process by the company began in 1903 when the company closed down all its furnaces operated by the mouth-blowing process and installed the then recently invented cylinder drawing process invented by John Lubbers. This process became successful for the manufacture of window glass and superseded the hand blowing process throughout the country and its use by the American Window Glass Company became the dominating factor in the window glass trade. However, the development of the sheet drawing process resulted in such lower costs that the cylinder process could no longer compete and the American Window Glass Company is now using a modified Fourcault method in their Arnold and Belle Vernon, Pa. factories and installing it also in their Jeannette, Pa. factory.

Recent Lecture on Glass

Professor Alexander Silverman, Head of the Department of Chemistry of the University of Pittsburgh, delivered an illustrated lecture on glass before the New Brunswick Scientific Society, New Brunswick, N. J., Wednesday evening, November 12.

Dr. Silverman returned October 12 on the *Lafayette* after a two months' visit to Belgium and France.

In Belgium Dr. Silverman was a delegate to the Tenth Congress of Industrial Chemistry and to the International Union of Pure and Applied Chemistry. At the former he delivered an illustrated address on "Recent Developments in American Glass Manufacture." Dr. Silverman made a study of educational and research institutions and the museums of both countries. He has purchased about a dozen new masterpieces in the field of glass art to be placed in the museum at the University of Pittsburgh. They include Daume, Lalique, Goupy, Galle, Walter, etc.

Only a Few Weeks Left for Preparation of Exhibits

At the Great American Ceramic Exposition, Cleveland, Ohio

Those in charge of the program and other activities of the Glass Division meetings to be held at the February Ceramic Congress at Cleveland, Ohio, are making strenuous efforts to assure the members who attend the series of meetings are expected to be the most profitable and satisfactory ever held by the Division. Interesting and valuable papers on appropriate subjects will be presented. Individuals and firms who have been hesitating about exhibiting their glass and other ceramic supplies and equipment before the throngs of interested visitors who will attend the American Ceramic Exposition, to be held concurrently in the Auditorium next February will need to make up their minds and bestir themselves at once if they wish to make space reservations before the best locations are all taken. Full particulars regarding this Exposition which is to be held in conjunction with the annual meeting of the seven divisions, including glass, of the American Ceramic Society may be obtained from the Society's Exhibition Manager, W. H. Eisenman, 7016 Euclid Avenue, Cleveland, Ohio, in charge of space, rentals, electric current, furniture, etc.

In accordance with the interest shown at the Toronto Meeting, the Art Division is planning to include in the Cleveland Exposition a showing of the best that is being made in household articles of clay or glass. If you are interested in having some of your best ware shown by the Art Division, just get in touch with Miss Marion L. Fosdick, New York State School of Ceramics, Alfred University, Alfred, N. Y., of the Committee on Exhibition, for full information.

THE CLEVELAND AUDITORIUM

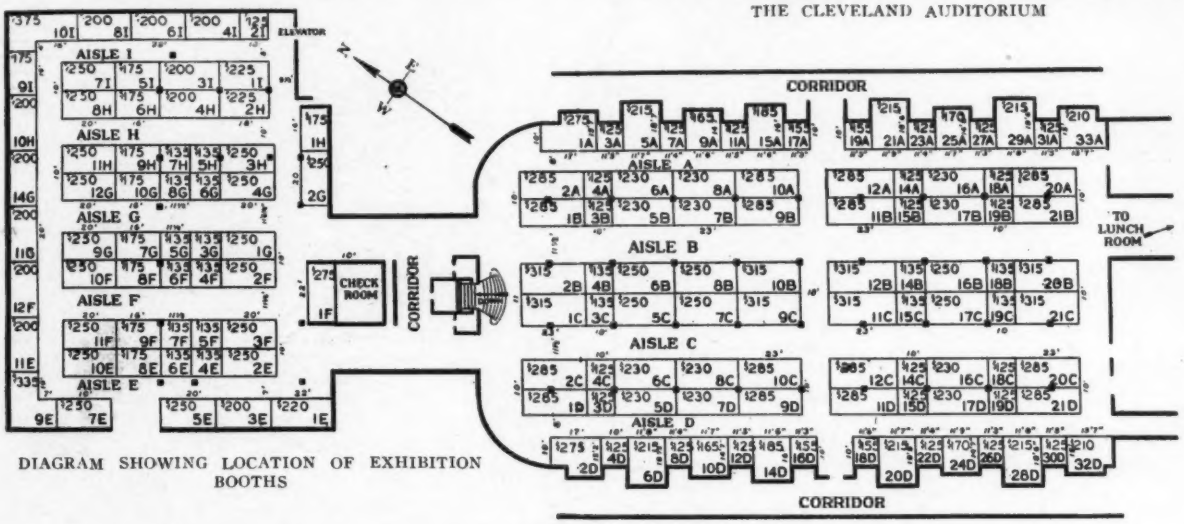


DIAGRAM SHOWING LOCATION OF EXHIBITION BOOTHS

Movies of Cove Point Meeting

The movie films taken by Roy Blunt, Aaron Lyle and Frank Preston, have now been developed and examined. All being well, they will be exhibited at the Cleveland meeting of the American Ceramic Society in February next, as a contribution of THE GLASS INDUSTRY towards the general interest of the proceedings. Come and see yourself in the movies. If you were not at Cove Point, come and see what you missed.

You never saw so many crabs in all your life.—*F. W. P.*

Personnel of U. S. Tariff Commission

Considerable interest is being manifested throughout the industrial world as to what the probable effect of the reorganization of the Tariff Commission be during the coming year. Various rumors have been in circulation and some predictions have been made concerning the President's use of the additional authority which has been placed in his hands in regard to the flexible provisions of the law.

The present membership of the Commission is as follows: Henry P. Fletcher, chairman; Thomas Walker Page, vice chairman; John Lee Coulter, Edgar B. Brossard, Alfred P. Dennis, Lincoln Dixon. Sidney Morgan is secretary of the Commission and its organization also includes Leland Harrison, chief, International Relations Division; E. Dana Durand, chief economist; John F. Bethune, representative in Europe; A. Manuel Fox, chief of the Economics Division; George P. Comer, chief Investigator; Charles E. McNebb, chief of the Legal Division.

Mr. Bethune, who has been active as secretary of the Commission during the past several years, has taken an important position representing the Commission in Europe.

Included also in the organization are several divisions, each headed by a chief corresponding to the several schedules of the Tariff Act—an Administrative Division, a Personnel Division, a Statistical Division, an Accounting Division, a Transportation Division, and a Library.

The United States Bureau of Mines has issued a report of Clark County, Nevada, in the southern part of the state on deposits of glass sand. The principal deposit is described as being in the form of a cross-bedded sandstone, very extensive. The chemical analysis is given by the Bureau as silicate 98.9%, iron oxide .05%, alumina .65%, lime .05%. Considerable quantities have been shipped to California glass plants. Preliminary examination of a deposit near Steamboat Springs, south of Reno and Washoe County, is reported. This is a virgin deposit and no chemical analyses have been made. Glass sand of a high quality is indicated, however.

The Position with Regard to the Dechema's Work on Standardization

The last semi-annual report of the Dechema, Deutsche Gesellschaft für chemisches Apparatewesen, General Office Seelze b. Hannover, on the position of its work of standardization at the end of June 1930 is able once more to indicate remarkable progress in the standardization of chemical apparatus. Up to this date about 80 pamphlets had been issued on this subject by the various sub-committees.

In particular the especially important standardization of apparatus for density determination, hydrometers and pyknometers, is now being undertaken in collaboration with other bodies engaged in standardization work.

A series of pamphlets on the standardization of rubber tubing, on the classification of laboratory glass according to its hydrolytic behavior, and on rapid methods for the investigation of glass apparatus and filter paper is nearing completion. The pamphlets issued by the sub-committee for acid-resisting stoneware are at the moment being considered by the testing department of the German Standardization Committee, and a series of further proposals for the standardization of important stoneware apparatus has already been published in "Die Chemische Fabrik," the organ of the Dechema.

At the Achema VI (this year's Exhibition of chemical apparatus organized by the Dechema) in Frankfort-on-the-Main the Standardization Committee of the Dechema was represented by a special exhibit which greatly impressed all those interested in this work.

Cottage Cheese and Sour Cream Jars

A general conference of representatives of manufacturers, distributors, and users of glass jars for cottage cheese and sour cream, held in Cleveland, Ohio, on October 23, 1930, under the auspices of the Division of Simplified Practice of the Bureau of Standards, Department of Commerce, unanimously adopted a simplified practice program recommending the 8, 12, and 16 ounce sizes as regular stock items for glass containers used in marketing these products. The conference also approved a simplified practice recommendation covering dimensions for the three sizes of jars. The action of the general conference will result in a reduction of variety from at least 20 sizes and types of jars, to 3.

The appointment of a representative standing committee of the industry was authorized to sponsor the recommendations and assist in the cooperative effort to enlist the support of industry.

The program, subject to approval by the industry, is to be effective from March 1, 1931.

Carrier Corporation Organized

The Carrier Engineering Corporation of Newark, N. J., widely known in the ceramic and allied industries as a result of its air conditioning and drying installations in clay product plants, will merge with the Brunswick-Kroeschell Company, New Brunswick, N. J., makers of refrigeration systems, and the York Heating and Ventilating Corporation, Philadelphia, Pa., it has just been announced. Including subsidiary and affiliated companies, the merger will unite fifteen concerns, five of them foreign, with total assets of approximately $15,000,000. All of the companies involved will retain separate entities under a holding company to be known as the Carrier Corporation.

"The consolidation will provide a single world-wide organization equipped to provide any desired kind of indoor atmospheric conditions in homes, hotels and apartment houses, stores, theatres, office buildings and industrial plants," J. I. Lyle, executive vice-president stated.

Glass Cylinders for Gasoline Filling Stations

Underwriters' Laboratories of New York, maintained by the National Board of Fire Underwriters, has no formal published specifications covering the design and construction of glass cylinders used in visible measure discharge devices, but their investigations of such devices, according to information received from C. W. Rulon, engineer for the Laboratories, includes a review of the analysis of the glass used in the device, together with a check of the physical dimensions, polariscopic examination for strains, and internal hydrostatic pressure tests and temperature shock test.

The hydrostatic test consists of a pressure of 50 pounds per square inch held one minute, and the shock test subjects the cylinders to a sudden temperature change from 32° F. to 212° F. and a reduction in temperature of 100° F. from hot to cool within this range without breaking or cracking.

Harbison-Walker Movie Film Available

The Harbison-Walker Refractories Company, producers of refractories, Pittsburgh, Pa., have just completed a 5,000-foot motion picture illustrating modern methods employed in the manufacture of refractories. The film shows every step in the production of refractories from the mining of raw materials to the loading and shipping of the finished product. Scenes in the research and control laboratories and some interesting animated photography showing the action of periodic and continuous tunnel kilns are also included in the picture.

This Harbison-Walker film, perhaps the most complete story of refractories ever made for the screen is available, without cost, to technical societies, engineering organizations, industrial organizations, universities, colleges, technical schools and research laboratories. It is suggested that early applications be made to Harbison-Walker Refractories Company, 1800 Farmers Bank Building, Pittsburgh, Pa.

To Alter Michigan Highway for Pittsburgh Plate

Local reports from Michigan towns stated early in November that the St. Clair county board of supervisors has voted at the request of W. W. Cox, county highway engineer, to change the location of two and one-half miles on trunk line M29 which is the shore road between Port Huron and Detroit, at Marysville, to permit construction of the Pittsburgh Plate Glass Company plant on the large tract of land purchased there recently.

Slight Gain in October Plate Glass Production

There was a moderate gain in the production of polished plate glass in the United States for the month of October, 1930. The total as reported by P. A. Hughes, secretary of the Plate Glass Manufacturers of America, Pittsburgh, Pa., was 8,583,295 sq. ft., as compared to 7,979,223 sq. ft. produced in the preceding month, September, 1930, and 14,620,904 sq. ft. produced in the corresponding month last year, October, 1929.

Peerless Glass Company, Long Island City, New York, who specializes in flint and green beers, minerals, food containers, etc., has taken a twenty-one year lease on property adjoining their present plant and are planning to construct a new warehouse on the site. This is the plant at which the lehr now known as the Dixon Auto-Thermal lehr was developed. They have been successfully operating their installation of four of these lehrs during the past two or three years and are now replacing some other old equipment in an adjoining tank building with an additional installation of four more lehrs.

The National Publishers Association, New York in bulletin No. 46 states that it is possible that Canada will impose a duty on U. S. publications including trade journals. There is a possibility that at the next session of Parliament this plan will be adopted. When discussed in 1926 it was suggested that the duty should be 10c per pound on the weight of the complete publication or 15c per pound on the advertising portion, the latter being the present duty applying on printed advertising matter in general.

American Standards Association Safety Code for the Installation of Pulverized Fuel Systems was recently revised. It covers the construction of buildings, housing, fuel, pulverizing equipment, ventilation of same, specifications for dust collection systems covering methods of preventing explosions through the drying of coal and its transportation through pipe lines.

The London Section of the Society of Glass Technology announced through the Hon. Secretary Verney Stott, the appointment of members of the executive committee of the Section for 1930-1 as follows: E. A. Coad-Pryor, B. P. Dudding, Dr. S. English, Colonel S. C. Halse, E. Meigh, W. W. Warren.

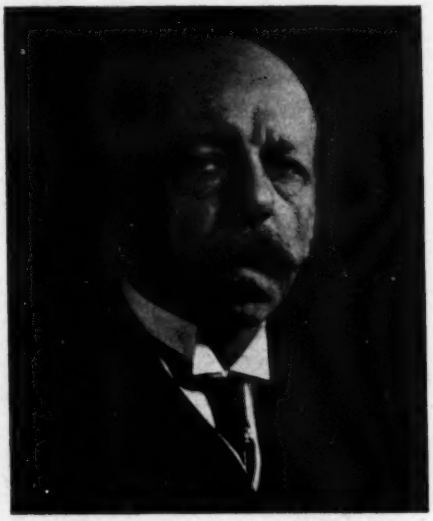
Members were elected by the London Section as follows: T. O. Blake, T. C. Crawhall, G. Lovell, G. I. C. Marchand, J. B. Murgatroyd, F. G. Orme.

Syndicate Glass, Inc., of Greencastle, Ind., has been organized with Wilbur S. Donner, Janet J. Donner and Robert H. Stevenson, incorporators. Capital stock is 1,000 shares without par value. The corporation will carry on the business of grinding, polishing, beveling, silvering and decorating glass.

Colef Glass Products Company, Benton Harbor, Michigan, has been incorporated by S. L. Charles and Sam J. Colef of that city. Capital $15,000.

Recent Deaths

Many readers no doubt will be interested in the accompanying portrait which recently came to hand, of the late Frederick Lyman Geddes, prominent citizen of Toledo, Ohio, member of the bar and senior member of Geddes, Schmettau, Williams, Eversman & Morgan, mention of whose death on October 9 in the Johns Hopkins Hospital, Baltimore, after a lengthy illness was made in the November issue. Mr. Geddes was closely associated with a number of the most important glass manufacturing companies of the country and was a director also in organizations devoted to several other branches of industry. At the time of his death, which was noted in the November issue, he was about 60 years of age.



FREDERICK LYMAN GEDDES

William Piez

William Piez, European Correspondent of Link-Belt Company, Chicago, and a brother of Charles Piez, chairman of the board of that company, died at Brussels, Belgium, on November 2 after a week's illness. Since 1928 he lived at Paris, France, where he functioned as European Correspondent of Link-Belt Company. He was born at Newark, N. J., in 1878.

Industrial Publications

Ferguson Cross Section. Published by the H. K. Ferguson Company, engineers and contractors, Hanna Building, Cleveland, O. The October numbers contain an illustration of the large modern swimming tank of the new Clubhouse and Recreation Building of the Corning Glass Works, at Corning, N. Y. This building was opened with formal exercises on October 7. It was constructed by the Ferguson engineering organization.

Coming Meetings

American Ceramic Congress and Exposition, February 23-27 inclusive, 1931, at the Cleveland Public Auditorium, Cleveland, Ohio. Ross C. Purdy, 2525 N. High Street, Columbus, Ohio.

The National Glass Distributors Association hold their annual meeting in Pittsburgh, Dec. 3 and 4.

The Pittsburgh Glass and Pottery Show takes place in Pittsburgh Jan. 12-24.

What the World Wants

Specific Inquiries for American Goods Received in the Department of Commerce, Washington, D. C. For further information write the department.

France—48555, Glassware, porcelain, and ceramic ware.
Spain—48585, Glassware, table.
Brazil—48499, Glass, window.
Port Rico—48450, Glass, window and plate.
England—48477, Glassware (fruit bowls, floating bowls with a figure in center, cake stands, etc.).
Canada—48428, Glassware, household.
Canada—48526, Glassware, and lamp chimneys.
France—48523, Glassware and pottery.

Readers Wants and Offers

Address answers to all "keyed" ads c/o The GLASS INDUSTRY 24 West 40th St., New York

EXPERIENCED GLASS MAN

Wanted: Experienced glass maker to take charge of modern plant equipped with continuous furnaces using natural gas. Successful applicant must be capable and have record of continuous successful experience elsewhere. Term contract if desired. Excellent opportunity for advancement with young concern. **All Replies Kept Strictly Confidential Being Seen Only by President of Company and Returned if Unsuccessful.** State age, education and experience first letter. Address "Classified D1."

PLATE GLASS WORKER

Wanted: Position in grinding and polishing department. Experienced plate glass worker with 30 years' experience in grinding and polishing wants position as foreman or divisional superintendent. Address "Classified D2."

"Glass Plant Engineers"
983 Front Street Toledo, O.
TOLEDO ENGINEERING CO., Incorporated

Current Prices of Glass-Making Materials

November 19, 1930

Quotations furnished by various producers, manufacturers and dealers.

Acid		Carlots	Less Carlots
Citric (dom.)	lb.	.46	.46
Hydrochloric (HCl) 20° tanks, per 100 lb		..	1.10
Hydrofluoric (HF) 60% (lead carboy)	lb.	..	.13½
52% and 48%	lb.	.10	.10-.11½
Nitric (HNO_3) 38° carboy ext. Per 100 lb.		5.50	..
Sulphuric (H_2SO_4) 66° tank cars	ton	15.50	..
Tartaric	lb.	..	.33½
Alcohol, denatured	gal.	..	.52
Aluminum hydrate ($Al(OH)_3$)	lb.	.04½-.05	.05½-.06
Aluminum oxide (Al_2O_3)	lb	..	.07
Ammonium bifluoride (NH_4) FHF	lb.	..	.19
Ammonia water (NH_4OH) 26° drums	lb.	.03	.03¼
Antimony, metallic (Sb)	lb.	..	.09½
Antimony oxide (Sb_2O_3)	lb.	..	.09½
Antimony sulphide (Sb_2S_3)	lb.	..	.14
Arsenic trioxide (As_2O_3) (dense white), 99%	lb.	.04	.04½
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	47.00	..
90% through 100 mesh	ton	44.00	..
Barium hydrate ($Ba(OH)_2$)	lb.	..	.05-.05½
Barium mixture, glassmaker's, f.o.b. St. Louis	ton	25.00	..
Barium nitrate ($Ba(NO_3)_2$)	lb.	.08	.08¼
Barium selenite ($BaSeO_3$)	lb.	..	..
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk, f.o.b. shipping point,	ton	15.00-16.00	18.00
Bone ash	carlots, lb.	.06	.06½
Borax ($Na_2B_4O_7 10H_2O$)	lb.	..	.0355-.0425
Crystal	lb.	.028-.033	..
Granulated	lb.	.025-.03	..
Powdered	lb.	.02875-.03375	..
Boric acid (H_3BO_3)	lb.	.0625-.07125	.06-.08125
Refined	lb	.0625-.07125	.07125-.08125
Cadmium sulphide (CdS)—			
Red	lb.	..	.70-.90
Orange	lb.	..	.70-.90
Yellow	lb.	..	1.30-1.50
Chromium oxide (Cr_2O_3)	lb.	.24	.26
Cobalt oxide (Co_2O_3)			
In bbls.	lb.	..	2.10
In 10 lb. tins	lb.	..	2.20
Copper oxide			
Red (Cu_2O)	lb.	..	.25
Black (CuO)	lb.	..	.18-.25
Black prepared	lb.	..	.22
Cryolite ($Na_3Al F_6$) Natural Greenland			
Kryolith)	lb.	.09	.10-.10½
Synthetic (Artificial)	lb.	..	.09½
Epsom salts ($MgSO_4$) (imported) Per 100 lb.		..	1.15-1.20
Feldspar—			
100 mesh	ton	12.50-20.00	13.50-22.00
80 mesh	ton	11.00-11.75	14.50
40 mesh	ton	11.00	13.50
20 mesh	ton	10.00	10.50
Fluorspar (CaF_2) domestic, ground, 95-98% (max SiO_2, 2½%)			
Bulk, carloads, f.o.b. mines	ton	32.50	..
In bags or barrels	ton	36.50	41.50
Imported	ton	36.50	38.50-40.00
Formaldehyde	lb.	..	.07½-.07¾
Graphite (C)	lb.	..	.04-.07
Iron oxide—			
Red (Fe_2O_3)	lb	..	.0450
Black (FeO)	lb	.04½	..
Kaolin (f.o.b. mine)	ton	8.00-9.00	..
English, lump, f.o.b. New York	ton	14.50-25.00	24.50-30.00

		Carlots	Less Carlots
Kryolith (see Cryolite)			
Lead chromate ($PbCrO_4$)	lb.		30
Lead oxide (Pb_3O_4) (red lead)	lb.	.760-.09¼	.08¾-.09½
Litharge (PbO)	lb.	.660-.08¼	.07¾-.08½
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	7.75	..
Burnt (CaO) ground, in bulk	ton	6.00	..
Burnt, ground, in paper sacks	ton	8.00	..
Burnt, ground, in 280 lb. bbls.	Per bbl.	2.15	2.30
Limestone ($CaCO_3$)		2.00-2.50	..
Magnesia (MgO)—			
Calcined, heavy (in bbls.)	lb.	.06	.07
light (in bbls.)	lb.	..	.23
extra light (in bbls.)	lb.	..	.37
Magnesium carbonate ($MgCO_3$)	lb.	.06	.07-.10½
Manganese 85% (MnO_2)	lb.	.03	.03
Nickel oxide (Ni_2O_3), black— for nickel content	lb.	..	.35
Nickel monoxide (NiO), green— for nickel content	lb.	..	.35
Plaster of Paris, bags	ton	21.00	23.00-29.00
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb.	.09	.09¼
Ground	lb.	.11	.12
Potassium carbonate—94-96%	lb.	.0555	.0555
Calcined (K_2CO_3) 96-98%	lb.	.06½	.07¼
Hydrated 80-85%	lb.	.05¾	.06¼
Potassium chromate (K_2CrO_4)	lb.	..	.23-.32
Potassium hydrate (KOH) (caustic potash)	lb.	.07¼	.08
Potassium nitrate (KNO_3) (gran.)	lb.	..	.06½-.06¾
Potassium permanganate ($KMnO_4$)	lb.	.16	.17
Powdered blue	lb.	..	.24-.26
Rochelle salts, bbls.	lb.	..	.19
Rouge	lb.	..	..
Rutile (TiO_2) powdered, 95%	lb.	.15-.20	.20-.25
Salt cake, glassmakers (Na_2SO_4)	ton	22.00	..
Selenium (Se)	lb.	..	1.80-1.90
Silver nitrate ($AgNO_3$)	(100 oz.) per oz.	..	.26¾
Soda ash (Na_2CO_3) dense, 58%—			
Bulk, on contract	Flat per 100 lb.	1.22½	..
In barrels	Per 100 lb.	1.55-1.57½	1.90-2.00
In bags	Per 100 lb.	1.37½-1.40	1.72½
Spot orders.. .025 per 100 lbs. higher			
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.07	.07½
Sodium hydrate (NaOH) (caustic soda) Solid	Per 100 lb.	2.95	..
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.	lb.	.03¾	.04½
95 per cent.	Per 100 lb.	1.96½-2.10	2.15-2.25
Sodium selenite (Na_2SeO_3)	lb.	..	2.00
Sodium fluosilicate (Na_2SiF_6)	lb.	.05	.05½
Sodium uranate (Na_2UO_4) Yellow or Orange	lb.	..	1.50-1.55
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb.	3.45	3.80-4.00
Flowers, in bags	Per 100 lb.	3.10	3.45-3.65
Flour, heavy in bbls.	Per 100 lb.	2.85	3.20-3.40
Tin chloride ($SnCl_2$) (crystals)	lb.	.37½	.39
Tin oxide (SnO_2) in bbls.	lb.	..	.33-.37
Uranium oxide (UO_3) (black, 96% U_3O_8)			
100 lb. lots. Black	lb.	..	2.75
Yellow	lb.	..	1.50
Zinc oxide (ZnO)	lb.	.03½	.12
American process, Bags	lb.	.06½	.07
Zircon			
Granular (Milled .005-.02c higher)		.07	.07½-.08
Crude. Gran. (Milled .005-.02c higher)		.03¼	.04-.05

Monthly Summary of United States Foreign Commerce in Glass

EXPORTS

Corrected to October 23, 1930

	September 1929 Quantity	September 1929 Value	September 1930 Quantity	September 1930 Value	Nine Months Ending September 1929 Quantity	Nine Months Ending September 1929 Value	Nine Months Ending September 1930 Quantity	Nine Months Ending September 1930 Value
Glass and glass products (Total)	.....	892,973	.....	741,547	.....	8,185,243	.....	7,035,689
Plate and window glass—								
Window glass, common, box 50 sq. ft.	1,118	5,682	2,112	12,772	13,383	78,101	14,084	76,854
Plate glass, unsilvered, sq. ft.	115,924	48,098	213,141	68,440	1,503,905	541,970	2,592,996	793,955
Other window and plate glass lbs.	364,048	41,615	323,588	27,529	3,385,966	369,374	4,098,905	350,272
Glass containers (bottles, vials and jars)	.....	339,585	.....	259,202	.....	2,762,204	.....	2,380,370
Table glassware, plain	.....	108,870	.....	89,696	.....	1,099,096	.....	887,754
Table and other glassware, cut or engraved	.....	11,115	.....	9,660	.....	88,989	.....	71,417
Lamp chimneys and lantern globes lbs.	155,843	30,941	68,384	12,294	1,271,605	256,114	950,336	176,935
Globes and shades for lighting fixtures lbs.	182,253	65,567	122,876	46,917	1,529,246	556,538	1,251,180	453,684
Chemical glassware lbs.	33,515	25,136	24,731	21,438	203,542	175,601	188,503	174,815
Electrical glassware, except for lighting lbs.	181,946	14,685	98,181	9,724	4,172,044	331,305	3,016,110	201,983
Other glassware	.....	201,679	.....	183,875	.....	1,925,951	.....	1,467,650

IMPORTS

Corrected to October 23, 1930

Glass and glass products	.....	1,387,992	.....	997,103	.....	10,742,358	.....	6,888,798
Cylinder, crown and sheet—								
Plain	dut. lb.	5,492,543	182,134	491,681	15,642	57,186,535	1,817,471	12,780,562	498,932
Bent, beveled, colored, etc.	dut. lb.	.....	44,031	.....	25,596	.....	431,743	.....	278,106
Made into mirrors	dut. sq. ft.	.....	.....	86	208	.....	.....	[2] 377	[2] 703
Plate glass—								
Plain	dut. sq. ft.	996,517	187,976	532,922	92,782	8,152,426	1,698,843	3,725,438	752,133
Bent, beveled, colored, etc., and mirrors	dut. sq. ft.	60,569	25,483	7,374	4,789	1,015,639	217,272	528,378	158,979
Rolled cylinder, crown, and sheet glass, ground, obscured, bent, beveled, colored, etc.	dut. sq. ft.	.....	.....	.....	4,360	.....	.....	.....	[2] 13,754
Laminated and plated glass	dut.	.....	.....	.....	3,750	.....	.....	.....	[2] 10,680
Bottles, vials, jars, and other containers	dut.	.....	25,366	.....	91,634	.....	188,575	.....	913,669
Scientific articles and utensils	dut.	.....	50,615	.....	33,051	.....	489,436	.....	410,085
Tubes and rods	dut.	.....	.....	.....	6,814	.....	.....	.....	[2] 22,673
Illuminating articles	dut.	.....	57,920	.....	46,857	.....	637,060	.....	456,510
Blown glass articles	dut.	.....	648,004	.....	547,241	.....	3,923,186	.....	2,382,171
Pressed glass articles	dut.	.....	29,962	.....	28,890	.....	228,645	.....	157,950
Other glassware	dut.	.....	136,501	.....	95,489	.....	1,110,127	.....	832,453

[2] Beginning June 18, 1930.

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